HISTORICAL POLAR BASES –
PRESERVATION AND MANAGEMENT

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Northumberland House, Fort Conger and the Peary Huts in the Canadian High Arctic: current condition and assessment of wood deterioration taking place

Robert A. Blanchette, Benjamin W. Held and Joel A. Jurgens

Wooden structures built in 1852 during the Franklin rescue expedition on Beechey Island (74°43'N, 91°54' W) and by American expeditions led by Adolphus Greely (1881) called Fort Conger (one of the first International Polar Year stations) and Robert Peary (1908) on Ellesmere Island (81° 44' N, 64°44' W) are deteriorating. Since little is known about the agents and processes involved with wood degradation in the Arctic, an assessment of the biological and non-biological degradation processes found at the sites, evaluations of the current condition of the wood and environmental monitoring over a 2 year period is reported. Wind erosion and salt efflorescence of the wood were types of non-biological degradation found. In addition, advanced decay by wood-destroying soft rot fungi was evident in all structures. Molecular characterization of the fungi causing decay indicated that they are a unique group of polar fungi with the capacity to survive extreme environmental conditions and cause significant degradation. Warming trends in the Arctic will undoubtedly increase degrade-
tive actions by these organisms and accelerate decay of the historic woods. Information on the various agents causing wood deterioration and decay at these historic sites and a better understanding of how degradation processes take place in the Polar environment can be used in management plans to help preserve this Arctic cultural heritage.

Introduction

In 1852, Sir Edward Belcher led a squadron of five ships in search of the lost expedition of Sir John Franklin. During the expedition a wooden store depot of supplies was erected on Beechey Island by the crew of the North Star under Commander W. J. S. Pullen. This building, called Northumberland House, represents some of the oldest introduced wood in the Canadian High Arctic. The building was still intact during a visit by the Captain Allen Young in the Pandora in 1875 (Young 1879) but deterioration has taken a significant toll on the structure and only ruins currently remain of the original building and contents. In addition to Northumberland House, graves from the Franklin expedition, monuments erected as memorials and several caches can be found on Beechey Island and add to the historic significance of the site (Phillips 1985).

A United States army expedition to the Arctic in 1881-1883 led by Adolphus Greely was part of an American contribution for the first International Polar Year activities. The expedition established Fort Conger at Lady Franklin Bay in northern Ellesmere Island. A very large wooden structure was built to house 26 members of the expedition during their exploration and scientific investigations. Unfortunately, relief ships carrying food supplies did not arrive and Greely was forced to abandon the Fort and head south in small boats. After an arduous journey and long periods of starvation at an improvised camp, only 6 survived and were rescued. Although the expedition ended in disaster, a large amount of scientific information was obtained and published (Greely 1886, 1888).

Fort Conger was a massive structure that was 16 m long, 5 m wide and had a 3 m high ceiling. It took enormous amounts of coal to heat the structure and was not well suited to the severe arctic environment. Robert Peary, who made many expeditions to the Arctic from 1890 to 1909, decided in 1900 to use Fort Conger as a wintering base. Robert Peary considered Fort Conger to be "a great barn of a structure... grotesque in its utter unfitness and unsuitableness for polar winter quarters" (Peary 1917) and his crew of Mathew Henson, Dr. T. S. DeWinnick and several Inuit dismantled most of Fort Conger and erected several small wooden shelters. The igloo-sized shelters were 2.2 to 3 m long and 2 to 3 m wide and were built low into the ground (Dick 2001). The huts were connected by a series of canvas covered passageways that became covered with hardened snow. Instead of a wooden hut, Peary decided to build a tent dwelling for his own living quarters that was covered by mattresses from Greely's Fort. Snow and ice was used to cover the tent and mattresses, providing a solid layer of insulation. Subsequent expeditions by American, Norwegian, Danish, and British/Canadian expeditions in 1915, 1920, 1921, and 1935 also used the structures and supplies left at the site. Today, Peary's tent cannot be found but the wooden structures and many other materials still remain at the site. The huts and wooden artifacts, however, are in various states of deterioration.

Wood in the polar environment is not free from degradation and these important historic wooden structures in the Arctic have suffered serious deterioration. Many forms of degradation continue to attack and cause significant losses. This report provides needed information on the current condition of the historic woods and gives new details on the destructive degenerative processes occurring in wood at these Arctic sites. This work was carried out under Scientific Research License numbers 010001 and 02011207-M from the Nunavut Research Institute and permits QQ-01-01 and QQ-02-04 from Quttinirpaaq National Park, Parks Canada.

Northumberland House

Large quantities of wood from the Northumberland House structure remain at Beechey Island and are protect- ed as part of Canada's National Historic sites. Although only a partial wall of the building is still standing, large

Wall boards, posts and various wooden artifacts associated with Northumberland House. This wood at Beechey Island is some of the oldest wood introduced into the Arctic by European explorers. Extensive decay is present in the wood and decay fungi are actively causing degradation. Photo: R.A. Blanchette
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Introduction

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Fort Conger was a massive structure that was 18 m long, 6 m wide and had a 3 m high ceiling. It took enormous amounts of coal to heat the structure and was not well suited to the severe arctic environment. Robert Peary, who made many expeditions to the Arctic from 1890 to 1909, decided in 1900 to use Fort Conger as a wintering base. Robert Peary considered Fort Conger to be “a great barn of a structure... grotesque in its utter unfitness and unsuitability for polar winter quarters” (Peary 1917) and his crew of Mathew Henson, Dr. T. S. Dodridge and several Inuit dismantled most of Fort Conger and erected several small wooden shelters. The igloo-sized shelters were 2.5 to 3 m long and 2 to 3 m wide and were built low into the ground (Dick 2001). The huts were connected by a series of canvas covered passageways that became covered with hardened snow. Instead of a wooden hut, Peary decided to build a tent dwelling for his own living quarters that was covered by mattresses from Greely’s Fort. Snow and ice was used to cover the tent and mattresses, providing a solid layer of insulation. Subsequent expeditions by American, Norwegian, Danish, and British/Canadian expeditions in 1915, 1920, 1921, and 1930 also used the structures and supplies left at the site. Today, Peary’s tent cannot be found but the wooden structures and many other materials still remain at the site. The huts and wooden artifacts, however, are in various states of deterioration.

Wood in the polar environment is not free from degradation and these important historic wooden structures in the Arctic have suffered serious deterioration. Many forms of degradation continue to attack and cause significant losses. This report provides needed information on the current condition of the historic woods and gives new details on the destructive degradative processes occurring in wood at these Arctic sites. This work was carried out under Scientific License numbers 0100501 and 0201122-M from the Nunavut Research Institute and permits QQ-01-01 and QQ-02-04 from Quittimnaaq National Park, Parks Canada.

Northumberland House

Large quantities of wood from the Northumberland House structure remain at Beechey Island and are protected as part of Canada’s National Historic sites. Although only a partial wall of the building is still standing, large
An illustration of Fort Conger as it appeared in 1881 (from Greely 1886). The structure was built by a U.S. army expedition led by Adolphus Greely and served to house the men and act as a research station during the first International Polar Year.

Little remains of the original Fort Conger due to dismantling by Peary and his expedition crew members in 1901 to make smaller dwellings for overwintering. Parts of the Fort's wooden floor, miscellaneous timbers and many artifacts are still at the site. Photo: R.A. Blanchette

The structure was built by Peary and his crew using wood from Fort Conger. Few people know that these historic structures are still present on the shores of Lady Franklin Bay and relatively little information has been published about them. Not used by Matthew Henson is on right and T.G. Deedrick's hut is at left.

Both photos: R.A. Blanchette

Fort Conger and the Peary Huts

The dismantling of Fort Conger by Peary and his crew left little of the original wooden structure at the site. Some foundation posts, beams and floor boards remain as well as many miscellaneous pieces of structural wood and wooden artifacts that are dispersed across a large area along the shore of Lady Franklin Bay. The largest section of floor remaining, approximately 4 x 2 meters, has floorboards raised 18 cm above the ground on sleepers running across the width. Many other artifacts made from metal, glass and other materials are also

numbers of the house posts and wall boards are on the ground within and around the location of the original structure. The structural wood present at the site is spruce, hard pine (most likely Picea abies and Pinus sylvestris) and oak. Some woods are affected by salt deterioration and have white delaminated surfaces. This type of non-biological degradation occurs in wood of historic huts at other polar locations and has been well described from the expedition huts located in the Ross Sea Region of Antarctica (Blanchette et al. 2002). It is caused by the corrosion of wood cells due to the chemical attack on lignin. Salts migrate into wood and accumulate resulting in the chemical degradation of the middle lamella between cells (the cementing material that holds cells together) and cells separate. Over time the cells on the wood surfaces become delaminated and detach. This process is relatively slow and gradually erodes the wood. Of greater importance is the destruction of wood by wood decay fungi. All woods have evidence of decay and many are affected with advanced stages of decay. There are several types of wood decay that occur throughout the world but only one form of degradation was found. This decay was characterized by cavities forming inside the secondary walls of wood cells and is commonly referred to as soft rot. Other types of wood decay, normally found in temperate regions of the world, were not found. Isolations from the decayed wood produced cultures that were identified by sequenc-
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Parts of the Fort’s wooden floor, miscellaneous frameworks and many artifacts are still at the site. Photo: R.A. Blanchette

Structures built by Peary and his crew using wood from Fort Conger. Few people know that these historic structures are still present on the shores of Lady Franklin Bay and relatively little information has been published about them. Hut used by Matthew Henson is on right and T.S. Deincker’s hut is at left.

Both photos: R.A. Blanchette

The Deincker hut at Fort Conger. All three hut structures used by the Peary expedition have had serious deterioration over the past decades and the degradation processes continue unabated. Outer boards of the hut’s multi-layered wall construction have blown off, windows and doors are open and the roof has blown off one hut. Non-biological deterioration (wind erosion and salt corrosion) as well as decay by wood destroying fungi has severely affected the wood in the huts.

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ing of the ITS region of rDNA. Many of the fungi obtained were Cadophora species that cause soft rot. Species of this genus have recently been found attacking wood in many locations in Antarctica and current information suggests that these decay fungi are indigenous to Polar Regions (Arenz et al. 2005, Blanchette et al. 2004).

The wood from Northumberland House has been in the arctic environment for over 150 years. Decay fungi have slowly caused considerable degradation and strength losses to the historic wood over the past many decades. The fungi are still active in the woods and continue to cause decay when the moisture and temperature conditions are favorable for degradation to occur.

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caused by soft rot fungi. The decay produced by soft rot fungi results in a distinct signature in the residual wood consisting of cavities formed inside the secondary walls of the wood cells. As the fungus continues its attack, the cavities enlarge and coalesce leaving large holes in the cell wall. In advanced stages of decay, most of the cellulosic secondary wall is removed leaving only a week skeleton of lignin in the remaining cells. Strength properties of the wood are greatly affected by the actions of the fungus. A major soft rot fungus found at the site was identified as species of the ascomycete, Cadophora. The decay fungi are still very active at the site and since plenty of moisture is present they continue to degrade the wood when temperatures rise above 0°C.

Environmental monitoring of temperature and relative humidity was done inside Henson’s hut and the Dedrick hut over a two year period. Conditions suitable for decay were found for long periods of time during the summer months. Moisture levels appeared conducive for decay and temperatures were above freezing for 1810 to 2195 hours per year. During the first International Polar Year, Greely’s expedition members monitored temperature and found in 1881 and 1882 that there were 1568 and 1691 hours respectively above 0°C (Greely 1888). In comparison to environmental data recently obtained in our investigations, there was approximately 2000 hours per year above 0°C or about 500 more hours per year than when the huts were built. Although only 5 years of data are being compared and more monitoring needs to be done to determine if this is an ongoing trend, any increase in temperature will allow additional time for fungi to grow and metabolize their substrate resulting in greater amounts of decay. Fungi are well adapted to respond quickly to environmental change and apparently can utilize increases in temperature to their advantage to grow longer and have increased decay rates (Gange et al. 2007). Warming trends in the Arctic will undoubtedly have a continued detrimental effect on historic woods by providing more time for these unusual wood destroying fungi to actively cause decay.

Deterioration of wood surfaces was found on some woods at Beechey Island and at Fort Conger. Salt accumulation is responsible for causing a chemical attack on wood that results in the separation and detachment of wood cells. Loose surface wood fibers are eroded off exposing new cells to the corrosive action of the salts. Sub photos: R.A. Blanchette

The effects of wind erosion on outer boards of Dedrick’s hut cause deep grooves in the wood. The less dense sapwood of the wood are eroded faster than the latewood giving a grooved appearance. An inscription, “CHIEF SIGNAL OFFICER WASHINGTON DC USA” placed on this reused wood during the Greely expedition (1881) has partially resisted the effects of the wind.

Conservation of historic wood in the Arctic

Great concern for the preservation of historic arctic sites and for the artifacts they contain has been expressed in recent years (Barr 2004, Chaplin 2004, Hatt 1985). However, the extreme climate and inaccessible location make preservation efforts exceedingly difficult. In addition, sites such as Fort Conger and the Peary huts are not well known and little has been published about them. Consequently, public interest in protecting this important polar heritage is very limited. Understanding the types of deterioration taking place at these arctic sites and understanding the mechanisms of degradation is a first step in developing successful conservation plans. Recently, research on the historic expedition huts of the Ross Sea Region of Antarctica has been carried out (Farrell et al. this volume) and the Antarctic Heritage Trust has assembled detailed plans to preserve the huts.
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The effects of wind erosion on outer boards of Dredrick’s hut cause deep grooves in the wood. The loss dense earlywood cells of the wood are eroded faster than the latewood cells resulting in a grooved appearance. An inscription, "CHEF SIGNAL OFFICER WASHINGTON DC USA" placed on this recorded wood during the Greely expedition (1883) has partially resisted the effects of the wind.

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Effects of wood decay by soft rot fungi in pine timber from Fort Conger. Cross section of wood cells shows the destructive attack by the fungus causing many cavities inside the wood cell walls. Wood strength is severely compromised in advanced stages of decay. Photo: Benjamin Held

![Graph showing temperature and relative humidity over time]

and obtain funds to carry out the work. A similar scenario is needed for historic huts in the Arctic if these monuments of polar heritage are to be saved. Serious deterioration has occurred at Northumberland House and in the remains of Fort Conger and the Peary huts. Of major concern is the serious wood decay taking place in the historic woods. This is no easy task to control especially since we know very little about these unusual polar microbes. More investigation is needed to better understand these decay fungi and their degradative processes so control methods can be realized. In the meantime, focus should be on general repairs to secure the Peary huts and altering microenvironmental conditions by improving drainage and reducing moisture in and around the huts. Since moisture is essential for decay to take place, reducing moisture in the woods will help to limit decay. Increased study and documentation of the wooden remains of Northumberland House and Fort Conger are also essential since decay is in advanced stages and degradation is continuing. Warming trends in the Arctic appear to be extending the time in which decay can take place and undoubtedly are accelerating decay rates so that these historic woods are being destroyed more rapidly.

Acknowledgements
The authors would like to thank Monty Yank and colleagues from Parks Canada for their assistance to carry out this work at Quttinirpaaq National Park and Beechey Island Historic Park. We also thank the Nunavut Research Institute and the Polar Continental Shelf Project for field travel and logistics in the Canadian High Arctic, and Jason Smith, Tim Filey and Mike Scombo for assistance in the field.

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Environmental monitoring within Inuusuaq’s hut shows temperatures above 0°C and relative humidity is sufficient for decay to take place over an extended period of time in the summer months. Comparisons made with data taken during the G CPS expedition in 1981 and 1982 indicate that the duration of time for decay fungi to be active (hours above 0°C) has increased by approximately 50% per year in recent times.

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