



EAST BASE, SOS: ASSESSMENT OF DETERIORATION AND RECOMMENDATIONS FOR CONSERVING THIS IMPORTANT ANTARCTIC HISTORIC SITE

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East Base is located on Stonington Island just west of the Antarctic Peninsula ($68^{\circ}11'S$, $67^{\circ}00'W$). It was built in 1940 and is the oldest standing United States base in Antarctica. Over the past decades, the wooden structures at the site have experienced serious deterioration. An assessment of the current condition of the historic structures was carried out in January 2007 as part of a cooperative expedition by the National Science Foundation and the British Antarctic Survey. Many forms of abiotic deterioration and biotic degradation are affecting the wooden buildings and artifacts. Wind is eroding the exterior wood surfaces and salt accumulations in wood cause corrosion and defibration. Wood and other organic materials in contact with the ground and where moisture accumulates are also being attacked by wood destroying fungi. Previous conservation work completed in 1992 at the site has helped to partially protect the buildings but deterioration since that time has increased. These historic structures urgently require conservation work to insure their preservation. Attention is desperately needed as soon as possible or the structures and artifacts at this important historic monument will be lost.

History of Site

East Base was constructed in 1940 by the US Antarctic Service expedition led by Admiral Richard Byrd. Stonington Island was chosen because of its unique southerly location along the Antarctic Peninsula and a glacial ramp connected the island to the Peninsula, providing easy access for dog-sledding teams to reach the mainland throughout the year. The base was occupied until March 1941, and later used by the British in 1946 as a temporary shelter while they were constructing their own base on the Island, designated as Base E. East Base was again occupied by the American Ronne Antarctic Research Expedition (RARE) in 1947 led by Finn

Fig. 1. East Base on Stonington Island, Antarctica showing the Ronne hut (left), Main Building (center) and Science Building with Met Tower (right) as they appeared during the assessment in January 2007.
Photo: Brett Arenz





Fig. 2. The Main Building showing collapsing floor built by British Antarctic personnel from Base E. This floor was built 4 feet above the original floor and covers historic artifacts, debris and ice. Photo: Brett Arenz

Ronne. This expedition remained at the site until 1948. During this time great advances were made in mapping the previously unexplored area of the peninsula south of Stonington. This expedition marked the first overwintering by a woman in Antarctica. After 1948, it was never again utilized by an American team but was used by the British at Base E until they abandoned Stonington Island in 1975 because the glacial ramp had deteriorated and access to the mainland was eliminated. An account of the history at East Base and condition of the buildings at the time was made by Lipps (1976).

Past conservation

East Base is the oldest existing United States Antarctic base and was designated Historic Monument #55 by the Antarctic Treaty nations in 1989. It was visited by personnel from the National Park service in 1991, and an East Base Management Plan was developed (Spude and Spude, 1993). This plan outlined several actions needing immediate attention and listed many long term recommendations. In 1992, some of the recommended repairs were made and the condition of the historic site further documented (Parfit, 1993). A more detailed account was also published on the project in 2002 (Broadbent and Rose, 2002). Since 1992, no other work has been done at the site and this paper provides an in-depth account of the deterioration taking place and documents the current condition of East Base.

2007 Assessment and Current Condition of East Base

There are 3 buildings currently standing at East Base: the Main Building (former bunkhouse), Science Building and Ronne Hut (Fig. 1). In addition, the floor timbers of two other buildings, the Machine Shop and a storage shed, are present. The original construction of the buildings was with 8 by 4 foot prefabricated panels with a plywood interior and a drop siding exterior. The 3/4 inch gap between the interior and exterior walls was filled with rock wool insulation. After construction, the buildings were covered with a layer of canvas to prevent wind and snow from entering the structures through cracks and crevices. Little of this canvas layer remains except at some sections on the main building that are leeward from the prevailing winds and partially covered by a large snow bank. Portions of each of the buildings were later covered with black "Ruberoid" felting material by British personnel at Base E. Some of this material still remains but most has been stripped away by the strong winds that occur at the site.

The British made substantial modifications to all three buildings and their original uses would not be readily apparent to a visitor without interpretive materials. The Science Building was used as a sledge workshop and for tent storage. The Ronne Hut was used as an emergency generator site and a concrete slab has

Fig. 3. Exterior north wall of the Main Building showing the loss of many wall boards.
Photo: Brett Arenz



been placed in a hole cut into the floor. The Main Building received the greatest modification of all three buildings as the original floor was apparently covered with a thick layer of ice when the British returned to Stonington in 1957 so they built another floor four feet above the original. A partitioning wall was constructed on the eastern side of the building which houses a room with the original floor. A large portion of the main building was used for storage and for seal processing as seal meat was used to feed the dogs on the sledging teams. Consequently the interior of the main building is filled with seal carcasses in addition to ice and other debris. The British-constructed floor is also collapsing in many areas making the interior of this building hazardous to enter (Fig. 2). There is a broken door on the north side of the building, and an entrance in the roof on the south side which provides entry via a ramp to the collapsing floor. The door on the eastern side of the building leading to the room with the original floor has broken off in the last 15 years, apparently due to corroded hinges. There is also a large number of missing roof timbers and wall slats on the building with many more timbers missing on the main building than the two other buildings (Fig. 3).

The Science Building and Ronne Hut are in relatively good condition compared to the Main Building. Because they were comparably weather tight, the conservators in 1992 chose the Science Building to set up a museum type display of artifacts that had been found outside (Fig. 4). These artifacts were from both the 1941 USAS and 1947 RARE Expeditions. Additionally, there are some materials, such as sledging flags and dog harnesses, from the time after 1948 when the British occupied the structures. A cache was also made in the Ronne Hut for additional artifacts that the 1992 conservation crew thought deserved additional protection.

In addition to the wooden structures, there are numerous dump sites and caches located around the buildings. These sites were mapped extensively and reported in the East Base Management Plan (Spude and Spude, 1993). Most of these materials were covered by a light layer of gravel by the 1992 team and they remain buried. No excavations were done and an assessment of their condition was not made. One dump site contains a World War I era light tank and an artillery tractor (Fig. 5). These vehicles were brought to the island by the USAS team in 1940 but proved to be of little use because of inadequate traction in the deep snow. Another object of historic interest is an aircraft engine still in its packing crate near the science building.

The cold temperatures of the polar environment have provided some protection from microbial decay, as compared to what may occur in temperate or tropical areas, and the isolated location of Stonington Island has saved artifacts from pilfering. However, significant and serious deterioration to the historic buildings and ar-



Fig. 4. Inside the Science Building showing the artifact display set up by the 1992 conservation team. Photo: Brett Arenz

tifacts is being experienced. Losses are occurring from environmental (wind) damage, salt defibration and biodegradation of wood due to fungal decay.

Exceedingly strong winds at the site can be very damaging. This was experienced during the site visit when winds of approximately 80 knots from the North East occurred for most of the day. Although this made outside assessment work virtually impossible, it did allow for valuable observations to be made on the effect of wind on the structures. With the eastern door having previously collapsed on the main building, wind was funneled into the room and pushed upward on the roof. On the southeast corner of the building, the roof was observed to rise up from the wall repeatedly throughout the day by about 15 cm. During this time, one roof board was observed to fly off the science building roof. This demonstrates the seriousness of the current situation and potential for the roof and walls of the building to be completely destroyed if conservation efforts are not initiated soon.

There is also evidence of surface erosion of wood boards due to the wind, but it appears to be limited because of the lack of small soil particles on Stonington Island. The heavy erosion of wood at the historic huts built by Scott and Shackleton on Ross Island seems to be exacerbated by the loose volcanic scoria on the ground that causes a sand-blasting effect when winds are strong. This small loose volcanic soil is not present at Stonington Island and the wood erosion observed here is probably primarily due to ice crystals blasting the wood during storms.

Salt corrosion of wood and surface defibration was also apparent on some areas of the wooden structures. This was most obvious on the interior walls of the meteorological tower attached to the science building. The process of salt corrosion of wood in polar environments has been previously described by Blanchette et al. (2002). Absorption of sea spray on wood and evaporation results in high concentrations of salts on wood surfaces. The high salt concentrations cause a chemical attack and a breakdown of the middle lamella that attach wood cells to one another. This leads to a defibrated "fuzzy" appearance on wood surfaces and detached wood cells that can easily become removed by the wind. Periodic rainfall occurring on Stonington Island can leach the salts from the wood and may be limiting the accumulation on exterior surfaces. In areas protected from rainfall, such as the windward-facing walls inside the science building where salt spray gets blown into the building, there is significant defibration. The collapsed door on the northern side of the met. tower is also an entrance facilitating entry of salt spray into the building interior, and the salt defibration is most notable at this location.



Another serious concern is degradation by wood-destroying fungi. Although wood decay may be considered unusual and unexpected in Antarctica, it occurs frequently on wood that has been introduced to the continent. Decay of historic woods in Antarctica was reported by Blanchette et al. (2004) occurring at the Ross Island historic expedition huts. Although the polar environment is exceedingly cold and dry, environmental monitoring within the Ross Island huts revealed that there were appreciable amounts of time in the Austral summer when temperatures are above 0 °C and relative humidity above 80% (Held et al., 2004) providing time periods that are conducive for fungal growth. In addition to concerns about the soft rot type decay that occurs in the wood other fungi, such as surface molds, cause dark discoloration on wood and other organic based artifacts. Evidence of the diversity and distribution of these species indicates that most of the species responsible for degradation are indigenous to Antarctica and therefore well adapted to the rigors and extremes of the Antarctic environment.

Our preliminary investigations at East Base indicate that soft rot fungi are present and are causing significant wood decay. Dark staining surface molds that disfigure wood are also present and causing problems. Taxonomic studies reveal that some of the same wood-destroying fungi responsible for the soft rot in the Ross Island huts, specifically fungi in the genus *Cadophora*, are also present on wood at East Base. The actual amount of wood decay in the various buildings and wooden artifacts at East Base was not able to be determined during this preliminary assessment. The amount of decay present in woods that are in contact with the ground needs further investigation to determine the extent of colonization and loss of structural integrity that has occurred.

The fungi most abundant as surface molds found inside the structures at East Base, specifically *Cladosporium* and *Geomyces*, also have been found at the Ross Island huts (Arenz et al., 2006). Interestingly, East Base is located nearly 10 degrees latitude further north than the Cape Evans hut on Ross Island and has a generally warmer and more humid environment, but our studies show fewer active molds inside the buildings at East Base. Environmental monitors were left at East Base in January 2007 and will be used to review precise environmental conditions at the site. Possibly, greater air circulation and drier conditions occur in these generally open buildings at East Base and this discourages mold growth.

Most of the windows and skylights in the building, having been broken or missing, were reinforced with Plexiglas by the 1992 conservation team. This seems to have been an effective repair as in only one skylight was an interior Plexiglas pane found to have subsequently fallen out, and no examples of broken panes were found. However, an attempt to protect the 1941 visitor welcoming message, left by then base commander Richard Black in the science building, seems to have had the opposite effect as it is now completely illegible. A Plexiglas pane was placed directly against the wall to cover the paper and this apparently trapped moisture behind it resulting in extensive fungal growth. A similar effect was found on two pages from Jennie Darlington's book "My Antarctic Honeymoon" (Darlington and McIlvaine, 1956) fixed to the wall in the partitioned smaller room in the main building. The pages were covered with mold and are becoming illegible due to the dark fungal discoloration caused by the Plexiglas trapping moisture which encourages their growth. Other interpretive panels placed in the science building that were completely enclosed from all sides are in good condition by comparison.

Recommendations

The deterioration occurring at East Base is significant and repairs, conservation and additional investigations are needed as soon as possible. All open or missing doors and windows in the three buildings should be repaired or replaced to preserve the remaining integrity of the structures. In the Main Building, all three entrances need to be closed to the outside environment; the broken door on the north side of the building, the open ramp entrance on the roof and the door on the eastern side. As a temporary repair, the eastern side door from the inside of the building was nailed shut during our visit but a more permanent repair is needed. If regular access for visitors to this room is desired, a door with non-corrodible hinges should be used. The Ronne Hut door is still in place but open and only a snow drift presently inside the room prevents the door from being completely opened. If this is to be a secure site for artifacts, the door must be secured. Repairing these openings will help protect the structures from the very high winds which occur here as well as helping to prevent some of the snow drifting inside, which when it melts will provide sufficient moisture needed for fungal growth to occur.



Fig. 5. Stonington Island has many large artifacts remaining from the 1941 expedition including a World War I era tank with tractor (in background). Photo: Brett Arenz

Significant work will need to be done on the roofs of all three structures to make them relatively weather tight. One particular weak spot is the roof on the south-east corner of the main building which moves up and down during windy days and may completely detach soon. Hopefully, repairs to the door made in January 2007 will help prevent wind from pushing the roof up from underneath and will at least allow it to remain attached. However, the roof must be reattached to the wall and reinforced for longer term structural stability.

The original conservation objectives for the buildings and artifacts outlined in the 1993 Conservation Plan written by the National Park Service (Spude and Spude, 1993) are for long term preservation efforts, and many aspects such as the biotic and abiotic degradation taking place are not addressed. If these historic buildings and artifacts are to be saved, an interdisciplinary team, such as that organized by the Antarctic Heritage Trust for preservation of the Ross Sea huts, should be established. Some immediate recommendations, however, can be made. Moisture must be excluded from the interior hut environment as this is supporting fungal growth and serious deterioration of the wood and artifacts. In addition to repairing the doors, work needs to be done to the roofs of all three buildings to make them reasonably water tight. If current environmental trends in the area continue, leading to warmer and wetter conditions, this will become even more essential. If left undone the existing decay fungi will progressively cause more damage and losses.

Although Stonington Island is relatively remote, it does receive visits by cruise ships, and over 600 signatures were counted in the guestbook that had been left by the conservators in 1992. Given current trends of increasing Antarctic tourism, this very significant historic site will undoubtedly have even more visitors in the future. Considering that parts of the huts could represent safety issues, particularly the false floor in the main building, work is needed urgently to deal with these concerns.

The presence of the United Kingdom's Base E just a few hundred meters away from the U. S. East Base and the historic use of Base E by the British after 1941 strongly suggest that any conservation efforts should be coordinated with the British Antarctic Survey. Both bases need conservation for successful preservation in the future. The success attained at East Base in exploring the geography of the Antarctic Peninsula would not have been possible without collaboration between the US and the UK, and the history of both sets of buildings is tied to each other. Collaborative efforts for conservation of both Bases are strongly encouraged to insure these important historic Antarctic sites are protected for future generations.

The site represents a remarkable period of history when the last of the empty spaces on the Antarctic map were being filled in, and rightly deserves its designation as an historic monument. The conservation work



done at this site in 1991 and 1992 was commendable, especially considering the short amount of time the team stayed at the site. However, the buildings at East Base are now at a critical stage. They are currently standing, but if current deterioration is allowed to continue their decline will not be a gradual one. The high winds in this area expose even small structural weaknesses to potential losses of building parts. The detachment of roof or wall boards will undoubtedly lead to rapid destruction and collapse of the entire structure. Michael Morrison, an architect from the United Kingdom who was a part of the BAS heritage survey team remarked that "I do think that a joint agreement over the management and future of the site is urgently needed between the United Kingdom and the United States. I feel that unless something is done urgently the situation will change from being a problem into being a disaster!".

Conservation work and continued investigations on the agents causing deterioration must be completed at this site soon or the opportunity for such work will be gone and this incredible monument to Antarctic exploration will be lost.

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