Kluane / Wrangell-St Elias / Glacier Bay / Tatshenshini-Alsek

2020 Conservation Outlook Assessment

SITE INFORMATION

Country: Canada, United States of America (USA)
Inscribed in: 1979
Criteria: (vii) (viii) (ix) (x)

These parks comprise an impressive complex of glaciers and high peaks on both sides of the border between Canada (Yukon Territory and British Columbia) and the United States (Alaska). The spectacular natural landscapes are home to many grizzly bears, caribou and Dall's sheep. The site contains the largest non-polar icefield in the world. © UNESCO

SUMMARY

2020 Conservation Outlook
GOOD WITH SOME CONCERNS

Finalised on 02 Dec 2020

The Kluane / Wrangell-St Elias / Glacier Bay / Tatshenshini-Alsek World Heritage Site protects a diversity of large, contiguous, intact ecosystems (from the highest peaks of the mountains and glaciers to the open Pacific Ocean, river systems of the Alsek River and sheltered inland fjords) that are strongly dominated by natural processes. This site is a dynamic and changing landscape which continues to evolve, albeit in a changing climate. Concern related to the site’s ecological integrity is triggered by recent climate change-related reductions and extinction of glaciers and the potential negative effects of ocean acidification. Other aspects of ecological integrity are good and the site represents an otherwise pristine system, which is well managed by the respective national and provincial agencies. Although greater coordination between these agencies may improve management further.
FULL ASSESSMENT

Description of values

Values

World Heritage values

▶ Area of exceptional natural beauty

This area of exceptional natural beauty encompasses coastal and marine environments, snow-capped mountains, calving glaciers, deep river canyons, fjord-like inlets and abundant wildlife abound (World Heritage Committee, 2016). The Tatshenshini-Alsek rivers and their wide U-shaped valleys are prominent natural features (IUCN, 1994).

▶ Outstanding examples of major ongoing glacial processes

The site contains outstanding examples of major ongoing glacial processes. Over 200 glaciers in the ice-covered central plateau combine to form some of the world’s largest and longest glaciers, several of which stretch to the sea. The site displays a broad range of glacial processes, including world-class depositional features and classic examples of moraines, hanging valleys, and other geomorphological features (World Heritage Committee, 2016). Approximately 35% of Wrangell St. Elias is covered by glaciers, making it the largest aggregation of glaciers in North America (NPS, 2016). Glacier Bay National Park preserves one of the largest units of the national wilderness preservation system, encompassing more than 2.7 million acres of glacially influenced marine, terrestrial, and freshwater ecosystems.

▶ Outstanding examples of major ongoing tectonic and geological processes

The tectonically active property features continuous mountain building and contains outstanding examples of major ongoing geologic processes (World Heritage Committee, 2016). The area is the most seismically active in North America, and is dominated by the St Elias mountains, including Mount Fairweather, the highest point in British Columbia. Mount Fairweather is one of the most spectacular natural features in a wilderness full of outstanding examples of geological and geomorphological processes (IUCN, 1994).

▶ Rich variety of terrestrial and coastal/marine environments with complex and intricate mosaics of life at various successional stages

The influence of glaciation at a landscape level has led to a similarly broad range of stages in ecological succession related to the dynamic movements of glaciers. Subtly different glacial environments and landforms have been concentrated within the property by the sharp temperature and precipitation variation between the coast and interior basins. There is a rich variety of terrestrial and coastal/marine environments with complex and intricate mosaics of life at various successional stages from 500 m below sea level to 5000 m above (World Heritage Committee, 2016). The Tatshenshini-Alsek rivers form a link between the existing World Heritage site in the Yukon and Alaska, resulting in a continuum of glacial activity and post-glacial ecological succession. The region contains the largest non-polar ice-cap in the world, over 350 valley glaciers, and about 31 surge-type glaciers (IUCN, 1994).

▶ Diversity of marine fauna

Wildlife species common to Alaska and Northwestern Canada are well represented, some in numbers exceeded nowhere else. The marine components support a great variety of fauna including marine mammals and anadromous fish, the spawning of which is a key ecological component linking the sea to
the land through the large river systems (World Heritage Committee, 2016). The Tatshenshini-Alsek river system contributes 95% of the chinook salmon, 90% of the sockeye salmon and 75% of the coho salmon for the commercial fishery in the Dry Bay area of the Gulf of Alaska (IUCN, 1994).

**Diversity of terrestrial fauna**

Populations of bears, wolves, caribou, salmon, Dall sheep and mountain goats that are endangered elsewhere are self-regulating here (World Heritage Committee, 2016). Nationally significant species include the "Blue" or "Glacier" bear, thought to be a colour phase of the black bear and found nowhere else in British Columbia or Canada, and considered rare in Alaska. The park provides an important travel route for waterfowl, with at least 40 bird species known to use the region. About 80 northern interior mammal and bird species also occur (IUCN, 1994).

**Other important biodiversity values**

**Flora**

The site contains 45 of the 600 rare vascular plant species found in British Columbia, including Alaska Nagoon berry, Fragile sedge and Wedge-leaved primrose. The diversity of vegetation in the region has resulted in the occurrence of large predators and ungulates, rated as nationally significant. As the wide valleys of the Tatshenshini and Alsek rivers pass through the St Elias mountains, they represent the only vegetated, low elevation and ice-free linkage for the migration of plant and animal species in the entire region (IUCN, 1994).

**Assessment information**

**Threats**

**Current Threats**

- Climate change represents the most significant existing and potential threat to the site’s values. Effects of climate change include retreat of glaciers and melting of permafrost soils, changing ocean temperatures and chemistry and ocean acidification, impacts on climate-sensitive and highly specialized species. Impacts of past mineral development on the area of Tatshenshini-Alsek Provincial Park, direct and indirect effects of commercial fishing in Glacier Bay National Park and Preserve, have been identified as existing threats to the site’s values; however, their impact is low. Commercial fishing conflicts and the lack of a legislated cooperative fishing plan with the State of Alaska is an impediment to protection of the marine resources. Disturbance caused by vessels and road vehicles to the environment and to some iconic fauna species generates important concern.

**Mining/ Quarrying**

*Impacts of past mining operations*

Previous mineral development in the area of Tatshenshini-Alsek Park and a pipeline adjacent to the Haines Road have left environmental liabilities which are being monitored (States Parties of Canada and the United States of America, 2006). Abandoned Mine Lands (AML) and abandoned oil/gas lands may have serious associated safety issues and resource impacts (Hood et al., 2006; State Parties of Canada and the United States of America, 2014). Wrangell-St. Elias National Park and Preserve has 92 mine sites and 29 mine features in need of reclamation in the park (Burghardt et al., 2014). The park is actively trying to reclaim and improve the safety of contaminated mining sites in the park and are actively trying to acquire the claims (NPS, 2016).

**Temperature extremes**

*Climate Change*

Effects of climate change include retreat of glaciers and melting of permafrost soils (States Parties of
Canada and the United States, 2014; Flowers et al., 2014; Shugar et al., 2017; Krebs et al., 2014). The warming trend over the last century (4.2°C) is projected to continue and model results indicate a further increase by up to 8.5°C by 2040 depending on the location within Kluane National Park and Reserve and RCP scenario (Parker, 2018). The trend of increasing total annual precipitation (~236 mm (100%) since 1945) is expected to continue with an increase of up to 200 mm from 2011-2040 (Parker, 2018). Wildfire season is expected to increase by over 60 days throughout most of KNPR (Parker 2018). The extent of glaciated areas in the park has decreased by 20% since 1958. Glaciers in KNPR are a major contributor to world hydrology. The high rate of mass loss observed in glaciers in the St. Elias region are a significant contributor to sea level rise, contributing to 8% of total sea level rise in the past 50 years. Impacts were evident in 2016 when the retreat of the Kaskawulsh Glacier diverted most water from the A’āy Chù/Slim’s River to the Kaskawulsh River.

The observed impacts of a warming climate includes declining sea ice, shrinking glaciers, thawing permafrost, changing ocean temperatures and chemistry, increased coastal erosion, and more extensive insect outbreaks, wildfire, plant productivity and diversity, ecosystems and predator-prey interactions (Grabowski, 2015; Larsen et al., 2014; Chapin et al., 2014; Markon et al., 2012; State Parties of Canada and the United States, 2014; Boonstra et al., 2018; NASA, 2018; Roland et al., 2019). Shugar et al. (2017) document a change in river flow from the rapidly retreating and thinning Kaskawulsh Glacier in Kluane National Park and Reserve; this change diverted most water from the A’āy Chù/Slim’s River to the Kaskawulsh River (IUCN Consultation, 2020) and is also associated with reduced fishing opportunities in Kluane Lake (Department of Fisheries and Oceans, 2018).

### Water Pollution

**Low Threat**

*Mercury Pollution*

Elevated mercury levels have been found in fish in Wrangell-St. Elias National Park and Preserve (Eagles-Smith et al., 2014). In a more detailed study for the park, mercury bioaccumulation and risk were found to be highly variable among lakes and species, which suggests the important role of the characteristics of each site and the need for more intensive sampling to develop appropriate risk benchmarks that show a more robust portrayal of ecosystem risk and allow the development of adequate regulations (Kowalski et al., 2014).

### Fishing / Harvesting Aquatic Resources

**Low Threat**

*Fishing*

In Glacier Bay National Park and Preserve, direct and indirect effects of commercial and sport fishing are likely occurring. Commercial fishing, principally for salmon (Oncorhynchus sp), Tanner crab (Chionoecetes bairdi), and halibut (Hippoglossus stenolepis), removes as much as half a million pounds of biomass from Glacier Bay National Park and Preserve proper’s marine waters annually. This removal of biomass has poorly known but likely important effects on marine ecosystems, including associated nearshore and riparian habitats. Regulations affecting commercial fisheries in Glacier Bay National Park and Preserve limit the types of allowed fisheries and the number of participants. Effective protection from fishing mortality of species with large movement patterns, such as tanner (Chionoecetes bairdi) and red skin (Paralithodes camtschaticus) crabs is challenging because they move between areas with and without fishing restrictions (Taggart et al., 2008).

Fish in KNPR are the only wildlife species Parks Canada permits harvest by licenced non-First Nation harvesters. Although gillnet surveys show a healthy and stable lake trout population in Kathleen lake, the angler survey in 2015 warns of an unsustainable recreational fishery. (Wong, 2017) In 2015 an angler survey was conducted and found that while most anglers were concerned about the spread of aquatic invasive species, 30% were unconcerned or neutral. This was concerning because 38% of anglers came from outside of Yukon. (Wong, 2016)
Glacier Bay National Park and Preserve regulates the number of vessels entering the bay and has a strict code of regulations about their movements (United States, eCFR, 2020). Nevertheless, some vessels are not subject to the quota system even though they contribute to environment disturbance (McKenna et al., 2017). Thereby, there is concern about the disturbance caused by small, medium and large vessels at different scales. Vessels affect emissions, air quality, visibility, noise, animal behavior and cause death or injury of whales in GBNP (Kipple and Gabriele, 2004; Mölders et al., 2013; McKenna et al., 2017; Molders and Gende, 2015; Frankel and Gabriele, 2017). In 2018 a cruise-ship accidentally leaked graywater in Glacier Bay National Park and Preserve (Resneck, 2019a). As a consequence of this and other previous events of illegal discharges, people have demanded suspension of operation permits until water and air pollution monitors are installed on ships in Glacier Bay National Park and Preserve (Ulrich, 2020). Vessel-whale collisions affect the humpback whale (Megaptera novaeangliae, LC) population in and near this park (Gende et al., 2011; Harris et al., 2012; Resneck, 2019b). Kittlitz’s murrelet (Brachyramphus bewirostris, NT) and marbled murrelets (Brachyramphus marmoratus, EN), considered rare birds are also disturbed by cruise-ships (Marcella, 2014; Marcella et al., 2017).

According to a recent Kluane National Park and Reserve bulletin, dated March 3, 2020, Dall sheep (Ovis dalli, LC) are increasingly susceptible to mortality from vehicle collisions on the section of the Alaska Highway at the base of the Thechâl Dhâl mountain (Parks Canada, 2020). Given the adverse effects of aircraft on disturbance-prone species such as mountain goats (Cote, 1996), the impacts and frequency of glacier air tours that may increase in popularity as glaciers retreat, should be monitored.

Potential Threats

Climate change represents the most significant potential threat to the site’s values. Effects of climate change include further retreat and extinction of glaciers, melting of permafrost soils, ocean acidification, decline or even loss of species with highly specialized climate niches (occurrence in high elevation, high latitude habitats), and impacts on human livelihoods. Disturbance caused by vessels and other transportation, military training, over-reliance on external funding, and petroleum spills have been identified as other important potential threats.

Habitat Shifting/ Alteration, Ocean acidification, Temperature extremes, Storms/Flooding (Climate Change)

Potential changes in vegetation cover due to climate change, are predicted for the Wrangell-Kluane complex, where it is expected to see an increase of woodland and temperate forest at the expense of tundra (Holsinger et al., 2019). Predicted core range for plant species in Haines Junction is expected to increase from 13 species, to 51 species by 2040 (Parker, 2018). These changes in vegetation cause cascading ecological responses as well as great concern and challenges for managers preserving biodiversity. An outbreak of spruce bark beetle (Dendroctonus rufipennis) caused unprecedented levels of mortality of white spruce (Picea glauca) in southwest Yukon and Alaska (Raffa et al. 2008) from 1995-to the mid-2000s. Most of the spruce dominated forest (82%) in KNPR was affected (49,000 ha). Within the attacked forest, on average almost half of the mature spruce trees were killed (44%; 2010 Parks Canada data).

Mammalian herbivores and the overall ecosystem in Kluane National Park and Reserve are likely to be impacted by climate warming due to disturbances caused by increased wildfire frequency, shrubification and rain-on-snow events (Boonstra et al., 2018). Rattenbury et al., (2018) predict that expected increase in adverse weather events may impact the populations of mountain ungulates. The decline in
Duke moose is likely explained by some combination of predation by wolves, and harvest by humans and winter conditions. Understanding climatic controls on the Park’s moose population which have low to no harvest will help understand the dynamics of moose populations outside of the Park (IUCN Consultation, 2020).

There has been a 72% departure from the historic level of wildfire with only 380 ha burned since 1950 in KNPR. A fire management plan is being developed. Changing fire weather and fuel structure may contribute to larger, more frequent and more severe fires than the historical average (Wong, 2017).

Increase of mean annual runoff mainly by rain input has been predicted for Glacier Bay National Park and Preserve and a peak flows shift from late summer to early fall (Crumley et al., 2019).

Acidification effects can include changes in water and soil chemistry that impact ecosystem health. (Schirokauer et al., 2014). Reisdorph and Mathis (2014, 2015) confirmed that the ocean waters of Glacier Bay National Park and Preserve are acidified. Due to rapid deglaciation occurring in Glacier Bay National Park and Preserve, neutral or slightly acidic fresh water is diluting the bay water and reducing its natural buffering capacity, against acidification (Ochs, 2017). Phase II of the study of ocean acidification in Glacier Bay National Park and Preserve ended in 2018. Results from this phase will help to understand the effects of acidification on the base of the food chain (Ochs, 2017).

Recent permafrost modeling for Wrangell-St. Elias National Park and Preserve predicts that only 42% of the park will be covered by permafrost by the 2050s (Panda et al., 2014), Wrangell-St. Elias National Park and Preserve State of the Parks Report (2016).

▶ **Air Pollution**

*(Air Pollution)*  

Low Threat  

Inside site, throughout (>50%)  

Outside site

Lacking significant sources of air pollution, the air quality is generally good. However, air quality is currently threatened by both global industrial pollution and local sources, such as cruise-ships (Geiser et al., 2010; Mölders et al., 2013; Mölders and Gende, 2015) and pollutants transported long distances (Weiss-Penzias et al., 2016).

▶ **Tourism/ visitors/ recreation, Other Activities**

*(Increasing pressure from cruise ship tourism)*  

High Threat  

Inside site, scattered (5-15%)  

Outside site

The cruise-ship tourism industry is significant in Alaska (Mölders et al., 2013, Young, 2014) and cruise-ship passengers represent >95% of visitors to Glacier Bay National Park and Preserve (Gende, 2007). Glacier Bay National Park and Preserve in particular receives high demand for access to tidewater glacier and this demand is likely to increase due to “last chance” tourism (Molders and Gende, 2015). The presence of cruise-ship and other vessels generates concern about impacts on biological resources, air quality, the underwater acoustic environment and visitor experience (Mölders et al 2013, McKenna et al 2017). The decline in the harbor seal (Phoca vitulina, LC) population in Glacier Bay National Park and Preserve is thought to be related to cruise-ship disturbance (Young et al. 2014). Disturbance from cruise ships could potentially impact the fitness and persistence of Kittlitz’ murrelet (Brachyramphus brevirostris, NT) and marbled murrelets (Brachyramphus marmoratus, EN) in Glacier Bay National Park and Preserve (Marcella, 2014, Marcella et al., 2017).

▶ **War, Civil Unrest/ Military Exercises**

*(Military training)*  

Data Deficient  

Inside site, extent of threat not known

Military overflights may affect the natural soundscapes and scenic quality in Wrangell-St. Elias National Park and Preserve (State Parties of Canada and the United States of America, 2014). However, military impacts are not significant as on average one exercise is carried out every five years (IUCN Consultation, 2020).
There is an environmental risk to coastal ecosystems in Wrangell-St. Elias National Park and Preserve by petroleum spills that can be potentially caused by marine vessels, small aircraft and associated fuel storage facilities, ATVs, historic drilling sites and storage areas (Hood et al., 2006). Ecosystems of Glacier Bay National Park and Reserve are also at risk of major oil spills (Eley, 2000; NPCA-NRDC, 2018).

While presently at a very low threat level, illegal hunting and poaching have occurred inside the Kluane National Park and Reserve. However, there has been no increase in illegal poaching noted in recent years (IUCN Consultation, 2020).

Climate change represents the most significant existing and potential threat to the site’s values. Effects of climate change include retreat of glaciers and melting of permafrost soils, changing ocean temperatures and chemistry and ocean acidification. Impacts of past mineral development on the area of Tatshenshini-Alsek Provincial Park, direct and indirect effects of commercial fishing in Glacier Bay National Park and Preserve, have been identified as existing threats to the site’s values; however, their impact is low. Commercial fishing conflicts and the lack of a legislated cooperative fishing plan with the State of Alaska is an impediment to protection of the marine resources. Disturbance caused by vessels and road vehicles to the environment and to some iconic fauna species generates important concern. Climate change represents the most significant potential threat to the site's values. Effects of climate change include further retreat and extinction of glaciers, melting of permafrost soils and ocean acidification. Disturbance caused by vessels and other transportation, military training, over-reliance on external funding, and petroleum spills have been identified as other important potential threats. Wildlife-vehicle collisions (on e.g., the Alaska Highway next to Kluane National Park and Reserve) and other forms of human-wildlife conflicts represent a potential increasing threat and source of mortality to wildlife and people and should be monitored especially as species' ranges and activity patterns shift under climate change.

Kluane / Wrangell-St. Elias / Glacier Bay / Tatshenshini-Alsek is a transboundary serial World Heritage site comprised of:

- Kluane National Park and Reserve of Canada
- Wrangell-St. Elias National Park and Preserve (USA)
- Glacier Bay National Park and Preserve (USA)
- Tatshenshini-Alsek Provincial Park (Canada)

In the United States, Glacier Bay National Park and Preserve and Wrangell-St. Elias National Park and Preserve are administered by the National Park Service. Kluane National Park Reserve is administered by Parks Canada. Tatshenshini-Alsek Provincial Park is administered by the Ministry of Water, Land and Air Protection in the British Columbia provincial government (UNEP-WCMC, 2011). All component
protected areas have their own management systems. However, there is currently no management agreement in place that would guide management of the entire transboundary World Heritage site (Cator, 2020).

**Effectiveness of management system**

Management of the individual component protected areas appears effective; however, the absence of an overarching management body for the entire World Heritage site is of some concern. Parks Canada has started the process of reviewing the management plan for Kluane National Park and Reserve for completion by 2020 (Parks Canada, 2019), however has experienced delays due to COVID-19 as all Parks Canada consultations and formal engagement on management plans are suspended until further notice (Parks Canada, 2020b).

**Boundaries**

The World Heritage site has been significantly enlarged through a number of extensions which added new components to it (World Heritage Committee, 1992, 1994). The boundaries are considered adequate to maintain its Outstanding Universal Values. The boundaries are known by the management authority but are not known by local residents, communities and landowners (States Parties of Canada and the United States of America, 2014).

**Integration into regional and national planning systems**

Integration into regional planning systems is mostly effective. Glacier Bay National Park, Kluane and Tatshenshini-Alsek cooperate on cross boundary river trips on the Alsek River. However, further collaboration between the US and Canadian parks is challenged by increased border security.

**Relationships with local people**

All component protected areas which comprise this site work to some extent with local communities and First Nations and their involvement in the management processes is assured. As an example, Wrangell-St. Elias National Park and Preserve collaborates with Ahtna Tribe to manage fish and wildlife resources (States Parties of Canada and the United States of America, 2014). KNPR is a co-managed park with a management board that is mandated through First Nations’ Final Treaty Agreements. Champagne and Aishihik and Kluane First Nations both have guardian programs. For example, the Kluane First Nation Guardian Program in the Yukon will be assessing moose and caribou populations as part of the 2020 round of federal funding supporting the Indigenous Guardians Pilot program (Pashagumskum, 2020).

**Legal framework**

Kluane National Park and Reserve is managed under the authority of the Canada National Parks Act and its associated regulations, and the Parks Canada Agency Act. Tatshenshini-Alsek Park was established in 1993 by the Province of British Columbia as a Class A Park under the Park Act by an enactment of the provincial legislature. Glacier Bay National Monument was established in 1926 and redesignated as National Park in 1980. Wrangell-St. Elias National Park and Preserve was established under the Alaska Natural Interest Lands Conservation Act (ANILCA). Both US parks' designated wilderness lands and waters are also managed under the Wilderness Act. Other laws that apply to Canadian national parks include: The Fisheries Act (1985); The Migratory Birds Convention Act (1994); The Species at Risk Act (2002); Impact Assessment Act (IAA) for Tat-Alsek and the Yukon Environmental Economic Assessment Act (YESAA). (States Parties of Canada and the United States of America, 2006; IUCN Consultation, 2020).

**Law enforcement**

Glacier Bay National Park and Preserve and Wrangell St. Elias have substantial law enforcement capabilities to provide resource and visitor protection. These parks have Visitor Use and Impacts Monitoring Program to detect and target problems impacting the Outstanding Universal Value of the site. Kluane and Wrangell-St. Elias collaborate on enforcement issues and share information.
### Implementation of Committee decisions and recommendations

No recent Committee Decisions

### Sustainable use

Traditional use of resources continues in some of the components of the site. Subsistence use in Kluane National Park includes the right to hunt, fish, gather edible plants and trap furbearing animals using traditional and current methods and equipment. Currently, subsistence activities in the park are low (Kluane Management Plan, 2010).

### Sustainable finance

The annual operating budgets of the component protected areas were: Kluane - $2 million; Wrangell-St. Elias (2016) - $6 million USD; Glacier Bay (2017) - $4 million; Tatshenshini-Alsek (2006) - $50 000 (Periodic Report, 2006). More recent figures are unavailable.

The over-reliance on cruise ship tourism and the funds generated through cruise ship fees in Glacier Bay National Park and Reserve, can have a potentially seriously effect on its management capacity and the economy of surrounding communities as revealed during the 2020 Covid-19 pandemic when cruise ship tourism stopped (Repanshek, 2020).

### Staff capacity, training, and development

Training and staff development are mostly effective.

### Education and interpretation programs

A number of education and interpretation programmes exist in all component protected areas. Glacier Bay receives funding from the cruise ship companies that supports extensive interpretive programs on the natural and cultural values of the site.

### Tourism and visitation management

Visitation is increasing at the site but management has so far been effective. Given the documented adverse effects on mountain goats of helicopter flights (Cote, 1996) the impacts of glacier air tours in Kluane National Park and Reserve - that may be growing in popularity as glaciers retreat - should be monitored. However, the majority of site-seeing tours are fixed-wing craft (ie. not rotorwing/ helicopter), which is more commonly used for Park operations and researchers.

### Monitoring

Long-term ecological monitoring programmes are in place, e.g. Kluane Ecological Monitoring Project (Progress report 2016). Glacier Bay is part of the Southeast Alaska Inventory & Monitoring Network of US National Parks (U.S.-National Park Service, 2019b) and Wrangell-St. Elias participates in the Central Alaska Inventory & Monitoring Network (U.S.-National Park Service, 2019a). However, there are no general environmental programmes in place or contemplated for Tatshenshini-Alsek Park. Specific environmental monitoring occurs for trails, wilderness campsites, mining sites and pipeline sites (States Parties of Canada and the United States of America, 2006). Ten-year monitoring of Tashenshini and Alsek rivers is reported by Downie (2014).

### Research

The acquisition of new information is a priority for managers of this site. Numerous opportunities exist for scientific research and are being pursued by scientists in the individual parks and by university and research institution-based scientists (Kluane Research Station, Arctic Institute of North America). Important scientific questions with the potential for major contributions to science are actively being pursued. Research priorities for park managers include climate change impacts (glacial retreat and ocean acidification) and effects of increased visitation on park resources. A formal research program does not exist for this World Heritage site, but ad hoc research needs are identified and funded with...
Academic institutes and federal and provincial research centres. Glacier Bay National Park and Preserve receives funding from the cruise ship companies that support substantial research activities. Over-reliance on this support could affect the continuity of research projects when unforeseen factors affect tourism in the region (Repanshek, 2020). There is considerable research, but it is not directed toward management needs and/or improving the understanding of Outstanding Universal Value (States Parties of Canada and the United States of America, 2014). Integration of western science and Traditional Ecological Knowledge could be improved (IUCN Consultation, 2020).

Overall assessment of protection and management

Protection and management of individual component protected areas that make up this serial transboundary site are highly effective. However, the absence of a management body for the entire World Heritage site is of some concern.

-Assessment of the effectiveness of protection and management in addressing threats outside the site

Although the US NPS maintains a cadre of air quality specialists that works closely with the air regulatory agencies, air pollution has been previously noted as a concern for the component protected areas in the USA. Air quality continues to be a concern.

-Best practice examples

Glacier Bay coordinates with cruise ship companies to limit the number of cruise ships entering the park. Wrangell-St. Elias collaborates with the Ahtna Tribe on the management of fish and wildlife resources. Parks Canada has installed warning signs along the Alaska Highway near Kluane Lake to help prevent Dall sheep-vehicle collisions and is considering additional ways of mitigating road mortality risks; in addition, Kluane National Park and Reserve, the Kluane First Nation, Dän Keyi Renewable Resources Council, Yukon territory, and the media (e.g., CBC Yukon) are raising awareness among motorists.

State and trend of values

Assessing the current state and trend of values

World Heritage values

- Area of exceptional natural beauty

The exceptional aesthetic values of the site have been well-preserved and remain largely intact. Glacier Bay and Tatshenshini-Alsek cooperatively manage and protect the wilderness character of the Alsek River. It provides a significant recreational opportunity and direct route through the coastal mountain range to the Pacific Ocean. Future changes in climate may negatively affect the visitor experience, but is not currently doing so.

- Outstanding examples of major ongoing glacial processes

The outstanding geological features of the site remain well preserved. However, its glaciers and associated processes are becoming increasingly affected by climate change (Molina, 2007, Das et al., 2014, Bosson et al., 2019). A number of glaciers have already shown significant retreat, including for example Muir Glacier in Glacier Bay National Park and Preserve and Kaskawulsh Glacier in Kluane National Park and Reserve.
IUCN World Heritage Outlook: https://worldheritageoutlook.iucn.org/
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▶ Outstanding examples of major ongoing tectonic and geological processes

The outstanding ongoing tectonic and geological processes of the site are well protected.

Low Concern
Trend: Stable

▶ Rich variety of terrestrial and coastal/marine environments with complex and intricate mosaics of life at various successional stages

The ecosystems of the site remain well preserved so far. However, significant concerns exist regarding future effects of climate change (Grabowski, 2015; Larsen et al., 2014; Chapin et al., 2014; Markon et al., 2012; State Parties of Canada and the United States, 2014; Boonstra et al., 2018; NASA, 2018; Roland et al., 2019).

Low Concern
Trend: Stable

▶ Diversity of marine fauna

This site offers protection for marine fauna. Glacier National Park is one of the largest marine mammal protected areas in the world, nevertheless the population of harbor seals (Phoca vitulina, LC) is decreasing for unknown reasons and iconic humpback whales (Megaptera novaeangliae, LC) are being disturbed by vessel collisions that cause death or injuries. There is also concern about how vessel noise affects marine mammals and other species (Kipple and Gabriele, 2004; Mölders et al., 2013; McKenna et al., 2017; Molders and Gende, 2015; Frankel and Gabriele, 2017).

Good
Trend: Stable

▶ Diversity of terrestrial fauna

Key terrestrial mammals including black bears (Ursus americanus, LC), brown bears (Ursus arctos, LC), moose (Alces americanus) and mountain goats (Oreamnos americanus, LC) are in good condition. Distribution patterns are expected to change over time due to changing landscape conditions following glacial recession and vegetation succession. Expected increase in adverse weather events may impact the populations of mountain ungulates (Rattenbury et. al., 2018). Because of the vastness of the site, the data on abundance levels and distribution of terrestrial mammals is limited.

Good
Trend: Stable

Summary of the Values

▶ Assessment of the current state and trend of World Heritage values

Populations of key terrestrial mammals including black bears (Ursus americanus, LC), brown bears (Ursus arctos, LC), moose (Alces americanus) and mountain goats (Oreamnos americanus, LC) remain in good condition. However, their distribution patterns are expected to change over time due to changing landscape conditions following glacial recession and vegetation succession. Marine mammals are facing threats that are being studied to determine the most effective management regulations. The exceptional aesthetic values of the site remain largely intact and its outstanding geological features remain well-preserved. However, the site’s glaciers and associated processes are becoming increasingly affected by climate change. In addition, ocean acidification is a major concern. Air traffic, including for glacier air tours (which may increase in popularity as glaciers retreat), such as that which flies through the Alsek river valley, should be monitored so that recreation does not impede wilderness character and values (e.g., disturbance-sensitive species like mountain goats).

Low Concern
Trend: Deteriorating

▶ Assessment of the current state and trend of other important biodiversity values

Vegetation cover, plant productivity and diversity are expected to be impacted by climate change.

Low Concern
Trend: Deteriorating
These changes in vegetation could cause cascading ecological responses and great concern and challenges for managers preserving biodiversity.

Additional information

Benefits

Understanding Benefits

► Sacred natural sites or landscapes
The site is the homelands of Native and First Nations peoples and they have lived on these lands for time immemorial. Cultural values and traditional practices guide the people as they lived and travelled in these landscapes resulting in a close connection culturally and spiritually to these landscapes.

► Wilderness and iconic features
In addition, this site is an outstanding area for contemplative reflection, one of the most important values of a protected area. The glaciers and valleys of this site provide the world’s most evocative scenery.

► Outdoor recreation and tourism
As the hardy visitors that reach this remote World Heritage Site can attest, Kluane / Wrangell-St Elias / Glacier Bay / Tatshenshini-Alsek is extremely important for recreation and tourism and contributes substantially to the local and regional economy of the gateway communities.

► Importance for research, Contribution to education
Glacier Bay considers scientific research to one of its primary purposes. Several long-term and very valuable projects (plant and stream succession, glaciology, humpback whales, harbor seals, oceanography) have been carried on and are ongoing as a result of the park’s research priority.

Local and traditional knowledge of the value of the site is an invaluable asset, with the importance of using both traditional knowledge and western scientific knowledge acknowledged through the site management processes.

► Tourism-related income, Provision of jobs
2017 cumulative benefits to local communities were estimated at USD 113,804,700 supporting 2,090 jobs at Glacier Bay National Park and Preserve and USD 104,859,200 supporting 1,366 jobs at Wrangell-St. Elias National Park and Preserve (Cullinane et al., 2018). 2019-2020 estimated visitation was 53,000 for KNPR, where approximately 30 staff are employed per year that support the local economy.

► Legal subsistence hunting of wild game, Fishing areas and conservation of fish stocks
The Alsek River ecosystem provides opportunities for subsistence uses, commercial fishing activities, and hunting.

Summary of benefits

Kluane / Wrangell-St Elias / Glacier Bay / Tatshenshini-Alsek World Heritage Site provides many benefits for local, regional, national, and international communities. These values include nature conservation values, spiritual values, recreational values, benefits to local communities and values related to naturally functioning ecosystems. Its international acclaim as an icon of nature conservation is uncontested. The Alsek River ecosystem provides opportunities for subsistence uses, commercial fishing activities, and hunting. KNPR and possibly the entire heritage site is not only important for its iconic landscapes and
natural beauty but the people that make this their home is as just as important.

## Projects

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<th>№</th>
<th>Organization</th>
<th>Brief description of Active Projects</th>
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<tbody>
<tr>
<td>1</td>
<td>Glacier Bay National Park and Preserve</td>
<td>Collaborated on research projects addressing key management issues related to vessel operations in the bay with a number of outside institutions, including: vessel generated acoustic impacts on marine mammals, ship-whale interactions, vessel-based disturbance of seals and Kittlitz’s Murrelets, and air emissions impacts from cruise ships.</td>
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<td>2</td>
<td>Glacier Bay National Park and Preserve</td>
<td>Collaborated on research projects addressing impacts of climate change on Glacier Bay system with a number of outside institutions, including ocean acidification, glacier status and trends, hydrologic modeling, and availability of ice habitat for harbor seals.</td>
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<td>3</td>
<td>Glacier Bay National Park and Preserve</td>
<td>Implemented new programs to increase communication and understanding between NPS and cruise ship pilots with the goal of protecting park resources, including: NPS staff involvement in Southeast Alaska Pilots Association meetings, distribution of whale sightings information for situational awareness (e.g., Whale Alert), shipboard observer program.</td>
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<td>4</td>
<td>Kluane National Park</td>
<td>Yukon Conservation Data Centre and Parks Canada, in partnership with the Kluane First Nation and Champagne and Aishihik First Nations, hosted the Yukon’s Canada 150 BioBlitz in the Kluane area, as well as in Kluane National Park and Reserve. The Kluane Bioblitz focussed on documenting the environment mainly around the south end of Kluane Lake both within and outside of the Kluane National Park and Reserve, with opportunities for the general public to participate and find as many species as possible within a short time, and over 47 visiting science experts professionally collecting data. In addition, talks, discussions, and expert-led nature walks about this unique environment were held (Bennett and Cannings, 2018).</td>
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<td>5</td>
<td>Glacier Bay National Park &amp; Preserve</td>
<td>Title: Identifying Vulnerable Mountain Goat Populations By Kiana Young (NPS, Trent University), Tania Lewis (NPS), Kevin White (ADF&amp;G), and Aaron Shafer (Trent University) Fieldwork: 2019-2020. &quot;A collaborative effort between state and federal agencies. The goal of this study is to identify vulnerable populations of mountain goats within the park so that the park can make informed management decisions when designing upcoming backcountry management plans and predict the impact that climate change will have on the populations.&quot;</td>
<td><a href="https://www.nps.gov/articles/identifying-vulnerable-mountain-goat-populations.htm">https://www.nps.gov/articles/identifying-vulnerable-mountain-goat-populations.htm</a>  </td>
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<td>6</td>
<td>Glacier Bay National Park &amp; Preserve</td>
<td>Title: Seasonal predation patterns of coastal wolves Glacier Bay National Park &amp; Preserve By Gretchen Roffler, Alaska Department of Fish and Game and Susannah Woodruff, Alaska Department of Fish and Game 2018-2023. &quot;The goal of this project is to characterize variation in seasonal patterns of wolf predation due to differences in prey vulnerability, and availability of alternate prey. Specifically, we will estimate wolf kill rates during late summer and late winter in a temperate coastal ecosystem. This research will further provide information regarding wolf prey selection in multiple-ungulate systems, the age and sex structure of the prey, and influences of the nutritional condition on kill rates.&quot;</td>
<td><a href="https://www.nps.gov/articles/seasonal-predation-patterns-of-coastal-wolves.htm">https://www.nps.gov/articles/seasonal-predation-patterns-of-coastal-wolves.htm</a>  </td>
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<td>7</td>
<td>Glacier Bay National Park &amp; Preserve</td>
<td>Title: Responses of Wildlife to Low Levels of Tourism by: Tania Lewis (NPS), Mira Sytsma (University of Washington), and Laura Prugh (University of Washington). Fieldwork: 2020. &quot;The goal of this study is to provide information to inform park management of the impacts to wildlife occurring across differing levels of human use to establish biologically relevant thresholds of human use to ensure that significant resource degradation does not take place. The specific goal of research in 2020 is to compare wildlife activity in years of normal visitation (2017-2018) with a year of very low visitation (2020) to determine the extent of human disturbance of wildlife.&quot;</td>
<td><a href="https://www.nps.gov/articles/responses-of-wildlife-to-low-levels-of-tourism.htm">https://www.nps.gov/articles/responses-of-wildlife-to-low-levels-of-tourism.htm</a>  </td>
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<td>8</td>
<td>Kluane National Park</td>
<td>Monitoring Programs: Kluane’s current ecological integrity monitoring program consists of 3 ecosystems (indicators): freshwater, forests, tundra with 5 measures each reflecting an important component of the park. This program monitors and designates the ecological condition as Good, fair, and poor with a trend of declining, stable or improving. Both Kluane First Nation and Champagne and Aishihik First Nations Land Guardians Programs provided technical support and assist in gathering cultural/traditional knowledge in the implementation of various monitoring, research and stewardship projects throughout their Traditional Territory for the Ecological Program, when possible. An extensive study is being conducted to try and understand the decline in population, work includes water quality monitoring of watershed, genetic sampling, and population surveys. Has received CoRe funding. Project will be done in conjunction with CAFN. <a href="https://www.pc.gc.ca/en/agence-agency/bib-lib/rapports-reports/core-2018/apercu-overview">https://www.pc.gc.ca/en/agence-agency/bib-lib/rapports-reports/core-2018/apercu-overview</a> A working group consisting of Kluane First Nation, Environment Yukon, Dän Keyi Renewable Resources Council and Parks Canada drafted a moose management strategy for promoting the long-term sustainable use of moose in the region. Understanding climatic controls on the Park’s moose population which have low to no harvest will help understand the dynamics of moose populations outside of the Park. (Wong, 2017) A CoRe project has been funded to examine the dynamics of fire and the KNPR forest. This will result in a Fire Management Plan and may result in prescribed burns. Project will be done in conjunction with CAFN and KFN The Sheep on the highway project (Parks Canada, 2020) resulted in a working group Parks Canada, the Dan Keyi Renewable Resource Council, Kluane First Nation and the Yukon Government (Highways and Environment)</td>
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## REFERENCES

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<td>NatureServe (2020). Bombus kluanensis. [online] Available at: <a href="https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.981...">https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.981...</a>; [Accessed 9 September 2020].</td>
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