What is the impact of a UNESCO status due to visitors on the environment of Herschel Island?

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A survey of the influence of trampling on vegetation

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List of Abbreviations

AWI	Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research
LCT	Last Chance Tourism
VT	Vegetation Type
UNESCO	United Nations Educational Scientific and Cultural Organisation
Convention	Convention Concerning the Protection of the World's Cultural and Natural Heritage
IFA	Inuvialuit Final Agreement
IGC	Inuvialuit Game Council
ISR	Inuvialuit Settlement Region
IRC	Inuvialuit Regional Corporation
ILC	Inuvialuit Land Corporation
IDC	Inuvialuit Development Corporation
IIC	Inuvialuit Investment Corporation
ICC	Inuvialuit Community Corporation
WMAC	Wildlife Management Advisory Council
HTC	Hunters and Trappers Committee

Abstract

With rising global tourism demand for wilderness and pristine habitats, the evaluation of anthropogenic impacts on the environment and preservation efforts has become more and more important. This study focuses on the Territorial Park Herschel Island Qikiqtaruk in the western Canadian Arctic, which has been on the tentative list for becoming a cultural and natural World Heritage Site since 2004. The study was conducted to determine the potential impacts of a designation in terms of visitor development and trampling disturbances.

A thorough literature review suggested a likely increase of tourist numbers after the granting of the World Heritage Status. In this thesis several visitor groups to Herschel Island were included, with a special focus on two main groups: cruise ship visitors and researchers, which make the bulk part of visitors to the territorial park. Park rangers and researchers helped to delineate trails commonly used by cruise ship visitors. GPS and DGPS datasets collected by researchers over the 2014-2017 period were used to show areas frequently visited for research activities.

In general, impacts from anthropogenic trampling directly result from the intensity of trampling but also vary substantially depending on the condition of the vegetation composition. The study identified two ecological classes overwhelmingly impacted by cruise ship visitors and where trail development might occur in the future. The paths used by researchers are more dispersed and the resulting light but steady trampling was also shown to result in vegetation alteration.

The impact of visitor disturbance on permafrost could not be evaluated directly on site, but a thorough literature review has shown a strong interrelationship between vegetation disturbances, trampling and permafrost thaw.

In conclusion, this thesis formulated and discussed several recommendations for Herschel Island Qikiqtaruk Territorial Park to mitigate effects of visitor impacts on vegetation, which are likely to increase with a rising number of visitors.

1. Introduction

All around the globe people crave to visit more of the world. Remarkable and remote places are particularly appealing to many travelers (Lemelin, Dawson, Stewart, Maher, and Lueck, 2010; Hall and Saarinen, 2010; Stewart, Howell, Draper, Yackel, and Tivy, 2009). Indeed, the overall amount of travelers rose by 7% in 2017 (UNWTO, 2018). This is directly related to the increasing availability of time and income for leisure activities (Stewart, Espiner, Liggett, and Taylor, 2017; Stewart et al., 2009). Thereof cultural and natural World Heritage Sites, designated by the United Nations Educational Scientific and Cultural Organisation (UNESCO) are often chosen as visiting destinations (Frey and Steiner, 2011; Meskell, 2013; Poria, Reichel, and Cohen, 2013; Ryan and Silvanto, 2010; Jha, 2005; Conradin, Engesser, and Wiesmann, 2015; Reinius and Fredman, 2007). The designation as World Heritage Site has been known to be a *"[...] confirmation that the area is beautiful and worth seeing"* (Reinius and Fredman, 2007, p. 10, para. 1).

Besides these noteworthy and designated sites the interest in unique, wilderness landscapes is on a steady rise (Tolvanen and Kangas, 2016; Reinius and Fredman, 2007). These places are expected to be as untouched as possible and simultaneously offer many options for leisure activities as hiking and camping (Lemelin et al., 2010; Tolvanen and Kangas, 2016). More and more people want to become explorers in their vacation and experience new adventures (Dawson et al., 2011). The Arctic is a region that encapsulates many of these aspirations. One option to explore this region is given by cruise ship operators (Blankholm, 2009; Dawson et al., 2011). Thus shipping activity in the Arctic is growing (Lasserre and Têtu, 2015; Stewart, Draper, and Johnston, 2005) and the ocean has become

one of the major developing areas of the tourism industry (Stewart et al., 2009; Stewart and Draper, 2006).

But tourism in these last wilderness regions also has its downsides. At some sites indigenous people suffer from visitor presence (Romaine and Gorenflo, 2017) and often nature does so as well (Forbes, Ebersole, and Strandberg, 2001; Tolvanen and Kangas, 2016; Stewart et al., 2005). 80% of the Arctic is supposed to be influenced by human activity in 2050 (Blankholm, 2009) and it is already known, that tourism activities lead to vegetation alteration (Forbes et al., 2001; Tolvanen and Kangas, 2016; Campbell, Claridge, and Balks, 1994). Several studies have shown that human impacts are related to type, time and intensity of use, as well as to the condition of the ecosystem (Forbes et al., 2001; Tolvanen and Kangas, 2016; Rausch and Kershaw, 2007; Walker and Walker, 1991). For example, processes of disturbance and alteration differ enormously between the Tropics and Alps (O'Neill, Balks, and López-Martínez, 2015; O'Neill, Balks, and López-Martínez, 2013; Ballantyne and Pickering, 2015; Stewart et al., 2017).

In recent years, Herschel Island Qikiqtaruk, a small island in the western Canadian Arctic, has become a favorite destination for several visitor groups. Since 2002 cruise ship visitors arrived on the island (Yukon Government, 2006; Yukon Government, 2018a). In addition, the Territorial Park is on the Canadian candidate list to become a cultural and natural World Heritage Site since 2004 (UNESCO World Heritage Centre, 2004). Besides pristine, Arctic wilderness, the island is characterized by a long settlement tradition (Burn, 2012). Therefore it is of outstanding universal value to humankind, which is required for the designation as World Heritage Site (UNESCO World Heritage Centre, 2004).

In the context of this thesis I will evaluate impacts for Herschel Island Qikiqtaruk Territorial Park that might result from the designation as World Heritage Site. A special focus will be set on visitors and management aspects. Simultaneously I will analyze the trampling impact on vegetation and permafrost from different visitor groups. This approach is meant to crystallize some of the main issues facing the park over the years to come. To support my approach, a comprehensive literature review of impacts and their mitigation

in places already undergoing such shifts will be the main part of this study. I will adress my findings in the light of ongoing climate change in the area. Climate change alone sets a high pressure on Arctic environments and might be directly and indirectly fortified by tourism development in the region (Dawson et al., 2011).

2. Aim of the Thesis

The overall aim of the thesis is to examine impacts of a potential cultural and natural World Heritage Status of Herschel Island Qikiqtaruk Territorial Park and impacts from visitor alteration associated with the UNESCO designation.

To achieve this aim, I asked four questions:

1. What is the trampling impact of visitors on vegetation?
2. What is the trampling impact of visitors on permafrost?
3. How will the number of visitors develop?
4. What is the influence of UNESCO guidelines on the management of Herschel Island?

The first two questions mean to document impacts from visitors on the environment of Herschel Island. Vegetation composition is an obvious characteristic of the parks environment and I wanted to examine how and if several user groups will lead to vegetation alteration. Permafrost conditions, instead, are unapparent to observe, but also potentially impacted by visitors and play a major role in Arctic environments. Therefore possible impacts from visitors need to be considered. The third question emphasizes the impacts of the prospective number of visitors on the environment of Herschel Island Qikiqtaruk. I wanted to know if there are obvious trends in the development of visitors and how the designation as a World Heritage Site might influence it. The last question aims to discuss potential upcoming changes regarding management decisions. I wanted to examine the administrative requirements associated with the World Heritage designation in the framework of a Canadian Territorial Park and the Inuvialuit Final Agreement (IFA).

3. Background

3.1. Herschel Island Qikiqtaruk

Herschel Island Qikiqtaruk (69° 35' 20" N, 139° 05' 20" W) is an Arctic island with an area of 116 km^2 located north of the Yukon Territory in the Canadian Beaufort Sea. It is the western most island of Canada and was formed during the last ice age. It consists out of diamicton refrozen as permafrost (Burn, 2012).

Herschel Island is located in the area of continuous permafrost (Cray and Pollard, 2018), which strongly impacts the water cycle and the type of vegetation (Burn, 2012; Myers-Smith, Forbes, et al., 2011; Wrona et al., 2016). Most parts of the island are vegetated by lowland tundra vegetation (Obu et al., 2017), which is also described as erect dwarf-shrub tundra (Wolter et al., 2016). 25% of the island are categorized as hummocky tussock tundra, whereas 32% are slightly disturbed uplands and 22% are moderately disturbed terrains (Obu et al., 2017).

The soils are primarily organic cryosols (Obu et al., 2017), which are characterized by a moderate cryoturbation, a process associated with freezing and thawing cycles (Haynes et al., 1998). The topmost layer consists of a thick, acidic organic layer (Cray and Pollard, 2018), which is determined by a relatively high nutrient availability in warmer months (Wrona et al., 2016).

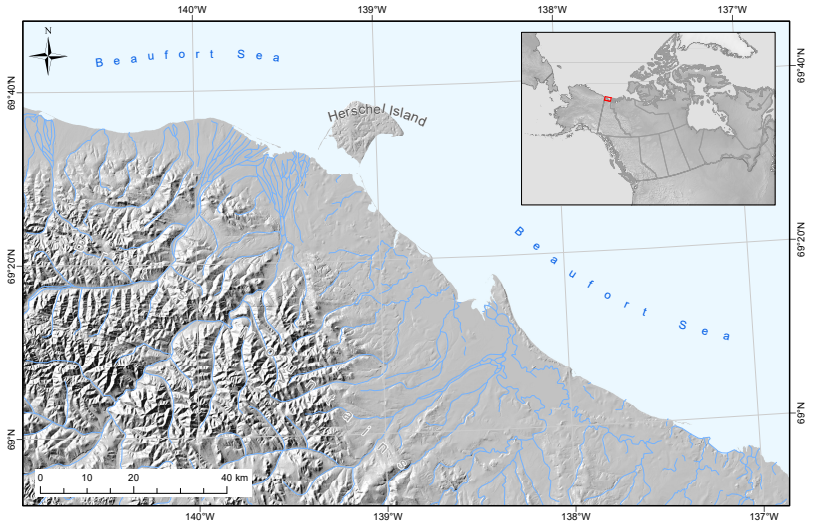


Figure 3.1.: Location map of the study site Herschel Island Qikiqtaruk Territorial Park, with the adjacent Yukon coast and an overview of the location at northern America.

Wildlife is abundant and diverse, with a particularly high bird diversity. Herschel Island is also a feeding ground for caribou of the Porcupine caribou herd. Muskox, Arctic fox and polar bears frequently visit the island (Burn, 2012; Yukon Government, 2006).

3.2. Ecology of Herschel Island

Herschel Island Qikiqtaruk is part of the Yukon Coastal Plain, which belongs to the Southern Arctic ecozone. The Arctic climate leads to a continuous snow cover from September to June. This results in a short growing season with corresponding low Arctic tundra vegetation (Yukon Government, 2018a). Over the last twenty years, rapid environmental change has been measured on Herschel Island (Myers–Smith et al., 2019). The research on permanent vegetation plots evaluated an encroachment of willows and polargrasses from 1999-2009 (Cooley, Eckert, and Gordon, 2012). The key driver of ecological changes in tundra ecosystems is temperature, but hydrological responses and soil chaacteristics can delay vegetation alteration (Wrona et al., 2016).

3.2.1. Ecological Classes

Ecological classes are used to classify the landscape and are based on soil conditions and vegetation types. They are useful terrain units to study impacts of trampling. As this study will focus on possible impacts by visitors to Herschel Island Qikiqtaruk Territorial Park, it is necessary to explain the unique ecological classes of the island. These classes have been established in an important study led by Smith, Kennedy, Hargrave, and McKenna (1989). They were also used in the master thesis of Eischeid (2015) to classify the landscape using remote sensing products. Eischeid (2015) adapted some of the ecological classes for her purpose and they will be used in this thesis as well. Each of the ecological classes is associated with one or more Vegetation Types (VTs). They will be explained in the section below.

Komakuk

The ecological class Komakuk is the most common class (44%) on Herschel Island. The active layer can be up to 50 cm thick and the soil is moderately well to imperfectly drained. The ecological class is most commonly associated with the *Willow/Dryas - Vetch* VT, but the *Cottongrass/Moss* VT might be present as well (Smith et al., 1989).

The *Willow/Dryas - Vetch* VT is associated with discontinuous vegetation cover and circular patches of bare soil. Beside patches of bare soil, dense patches of *Dryas integrifolia* and bryophytes occur. The dominant shrub is *Salix arctica*, with approximately 10% cover. Diverse forbs are also present in low percent cover, but high in frequency. This VT is probably stable and seen as a climax vegetation (Smith et al., 1989).

The *Cottongrass/Moss* VT builds a dense vegetation cover. The most common plant is *Eriophorum vaginatum* (10-20% cover) and therefore some regions of the Komakuk class are referred to as ”tussock tundra”. The few established shrubs are dominated by *Salix spp.*, but also Ericaceous shrubs are present. In a diversity of other forbs *Dryas integrifolia* is

most common. Also typical is a well-developed moss layer with a cover between 20-70%. Even *Spaghnum spp.* appears sporadically and Lichens are present in small amounts. This VT seems to be a climax vegetation on Herschel Island. Still, this long established equilibrium is sensitive to disturbance due to thaw sensitive, near-surface permafrost (Smith et al., 1989).

In general, Komakuk associated with *Willow/Dryas-Vetch* VT seems to be less sensitive than others. It will sustain foot traffic and trail development. Other parts of Komakuk associated with *Cottongrass/Moss* VT are sensitive to minor disturbances and should not be used for hiking (Smith et al., 1989).

Plover-Jaeger

The Plover-Jaeger class is combined out of the two different ecological classes Plover and Jaeger from Smith et al. (1989). On Herschel Island these ecological classes are difficult to distinct in the field and were therefore combined by Eischeid (2015). The combined ecological class is often found on gentle slopes and moderately eroded terrain. It is characterized by little to extensive bare ground and seen as transitional class between the ecological classes Thrasher and Komakuk. The active layer is approximately 46 cm thick and the soil pH is around 6-7.8 (Eischeid, 2015).

This ecological class is associated with the VTs *Willow/Saxifrage - Coltsfoot* and *Willow/Dryas - Vetch*. Both VTs are dominated by willow species, mostly *Salix spp.*. The *Willow/Saxifrage - Coltsfoot* VT is characterized by a continuous moss cover and frequently occurring forbs with low percent cover. Slumping in this VT is common and due to unstable vegetation and soil. Therefore, the VT is not seen as climax vegetation and often follows after pioneer vegetation. Compared to the *Willow/Saxifrage - Coltsfoot* VT, the *Willow/Dryas - Vetch* VT is relatively stable and seen as a climax vegetation (for further description of the *Willow/Dryas - Vetch* VT see subsection 3.2.1) (Smith et al., 1989).

In conclusion the ecological class Plover-Jaeger seems to be sensitive to disturbance where it is associated with *Willow/Saxifrage - Coltsfoot* VT. Foot traffic does only not have an impact during the driest time of summer. Developing trails are permanent subjects to slumping, even so ground provides attractive hiking conditions. Plover-Jaeger seems to be more stable at places associated with the *Willow/Dryas - Vetch* VT (Smith et al., 1989; Eischeid, 2015).

Shrub Zone

The ecological class Shrub Zone has been added by Eischeid (2015). It is still new and not as extensive described as the ecological classes of Smith et al. (1989). Soil characteristics and associated VTs are still undefined. Nevertheless, the ecological class is supposed to be associated with the correspondent, also newly added Shrub Zone VT. So far, it is characterized by high, dense shrubs, mostly *Salix richardsonii*. Other species found in this ecological class are *Salix arctica*, *Salix reticulata*, *Equesitum sp.* and *Petasites frigidus*.

In general this ecological class is supposed to be linked to flooded plains, but often appears drier and less associated with hydrophilic plants. The active layer is $<$59 cm deep and carbon and nitrogen stocks in the soil are highest in this ecological class. Patches of bare ground seem to be rare (Eischeid, 2015).

Thrasher

The ecological class Thrasher is characterized by mass movement erosion and extremely unstable slopes. Its active layer is relatively deep (up to 80 cm). The soil pH is slightly basic (7.2-7.8) and the soils are well to moderately drained (Smith et al., 1989).

The associated VTs are affected by the occurring instability. Most common is the *Arctic Willow/Lupine - Lousewort* VT complemented by the *Grass/Chamomile - Wormwood* VT at more stable patches. The *Arctic Willow/Lupine - Lousewort* VT is dominated by *Salix arctica*

(15-50%) and *Salix reticulata* (1-20%), in a prostrate layer. The forb layer underneath is extremely robust and dominated by *Dryas integrifolia* and *Lupinus arcticus.* A well developed moss cover is present between forbs and willows. Due to the unstable soil underneath the vegetation is under steady change. It likely develops into the *Willow/Saxifrage - Coltsfoot* VT (see subsection 3.2.1) (Smith et al., 1989).

The *Grass/Chamomile - Wormwood* VT is also often present after erosional incidents with high percentage of exposed soils. The VT is dominated by *Gramineae* and non-vegetated ground is still a present feature. The vegetation is seen as an early successional type, which will change as soon as stable conditions develop (Smith et al., 1989).

In general this ecological class should be avoided for any infrastructure development due to its instability. If there were any disturbances due to hiking or exploration, the resulting impacts would be still less than the occurring natural erosion (Smith et al., 1989).

Wet Terrain

The Wet Terrain ecological class has also been added by Eischeid (2015). It is supposed to describe areas close to creeks, that are flooded on a regular basis. Due to the flooding, new material might be deposited and a thick active layer (approximately 50 cm) forms.

Most common plant species are *Petasites frigidus* and *Equesitum spp.*. Although different plants might dominate, the ecological class usually is associated with the *Willow/Saxifrage - Coltsfoot* VT (see subsection 3.2.1) (Eischeid, 2015).

Orca

The Orca ecological class describes a few large alluvial fans on Herschel Island. They account for ≈1% of the area and include all forms of alluvium on the island. Active deposition

takes place and the ecological class lacks the typical micro-hummocky surface (Smith et al., 1989).

The associated VT is the *Sedge-Grass* VT. It is characterized by a permafrost table <50 cm below the surface and dominated by *Carex aquatilis* (15-50% cover). In a few cases other grasses or sedges than *Carex aquatilis* dominate (Smith et al., 1989).

In general the Orca ecological class is characterized by smooth and occasionally wet surfaces. The soils are sensitive to hiking disturbances. One of the large alluvial fans on Herschel Island begins behind the settlement at Pauline Cove and surround the area of the whalers and Inuvialuit graves (see figure 5.4, p.43) (Smith et al., 1989).

3.2.2. Soil

The soils on Herschel Island are classified in the Canadian system of soil classification. Widely organic cryosols dominate the island's surface. Most typical subtypes are turbic cryosols and static cryosols (Obu et al., 2017). Turbic cryosols show distinct features of cryoturbation and develop into mineral soils. Permafrost can be found within 2 m below the surface (Haynes et al., 1998). Static cryosols usually develop from coarse-textured mineral material or at recently disturbed sites. They are defined by the absence of cryoturbation. The organic layer may be less than 40 cm thick and permafrost exists not more than 1 m below the surface (Haynes et al., 1998).

Permafrost landscapes in general are environments which often accumulate organic matter at the surface (Obu et al., 2017). They represent 26% of terrestrial soil ecosystems and recent research suggests that microbial life persists within the permafrost, which might have an important impact on global biogeochemical processes (Steven, Léveillé, Pollard, and Whyte, 2006).

Especially in boreal, subarctic and arctic landscapes, soil characteristics like nutrient availability, water drainage and mechanical properties determine the vegetation growth and

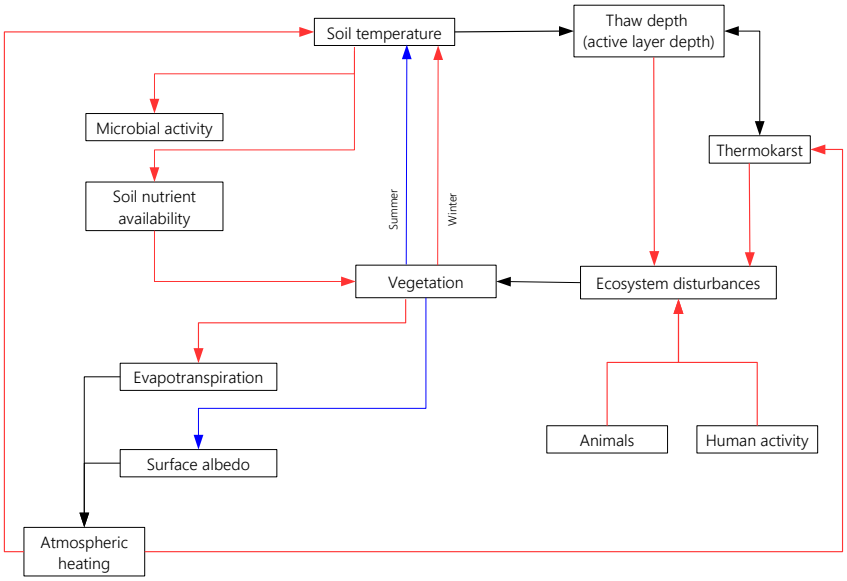


Figure 3.2.: Flowchart of the soil and vegetation interaction derived from Wrona et al. (2016) and slightly rearranged. Red arrows indicate positive relationships (e.g. more vegetation leads to higher soil temperatures in winter). Blue arrows indicate negative relationships (e.g. more vegetation leads to lower soil temperatures in summer). Black arrows indicate strong linkage and influence between the characteristics.

composition (Hermanutz, 2016; Wolter et al., 2016). Due to permafrost and machanical conditions, the soil regulates the water ability for plants with an inverse relationship between the retaining availability of water of the soil and the access of plants to it (Hermanutz, 2016). Therefore changes in microtopography can alter vegetation composition and active layer depth. Soil characteristics influence the vegetation pattern and so does the vegeration on soils (Wolter et al., 2016).

3.3. Structure of Administration

Herschel Island Qikiqtaruk has become a Yukon Territorial Park on July 30th, 1987 (Yukon Government, 2006; Indian and Northern Affairs Canada, 1984) and was proposed for nom-

ination as World Heritage Site in 2004 (Burn, 2012; Yukon Government, 2018a; UNESCO World Heritage Centre, 2004). Since the establishment of the territorial park, it is managed by the Yukon Territory Government and co-managed with the Inuvialuit. It is part of the Inuvialuit Settlement Region (ISR) and falls under the Inuvialuit Final Agreement (IFA) (Indian and Northern Affairs Canada, 1984). This territorial park has to be managed in the same manner as a national park (Indian and Northern Affairs Canada, 1984; Yukon Government, 2006; Yukon Government, 2018a). The park consists of two zones, the wilderness territorial park and the historic territorial park. The historic territorial park contains the lands adjacent to Pauline Cove, whereas the wilderness territorial park includes the rest of the island (Burn, 2012).

3.3.1. Inuvialuit Final Agreement

The Inuvialuit Final Agreement (IFA) is an agreement between the Committee for Original Peoples Entitlement, which represents the Inuvaluit of the Inuvialuit Settlement Region (ISR), and the Government of Canada represented by the minister of Indian Affairs and Northern Development. This agreement aims to preserve the cultural identity and values of Inuvialuit in a changing society. By law, Inuvialuit are equal and meaningful participants of the development of the far north of Canada. Besides rights of indigenous people, the agreement means to protect Arctic wildlife, environment and biological productivity (Indian and Northern Affairs Canada, 1984). Therefore *" [...] the Inuvialuit cede, release, surrender and convey all their aboriginal claims, rights, title and interests, whatever they may be, in and to the Nothwest Territories and the Yukon Territory"* (Indian and Northern Affairs Canada, 1984, p. 5, para. 3.5).

To manage this region for further development, different corporate structures were established. These structures are meant to be beneficial for Inuvialuit and care for their rights. The Inuvialuit Regional Corporation (IRC) is a corporation without any share capital, which receives the settlement lands and financial compensation at first. The received

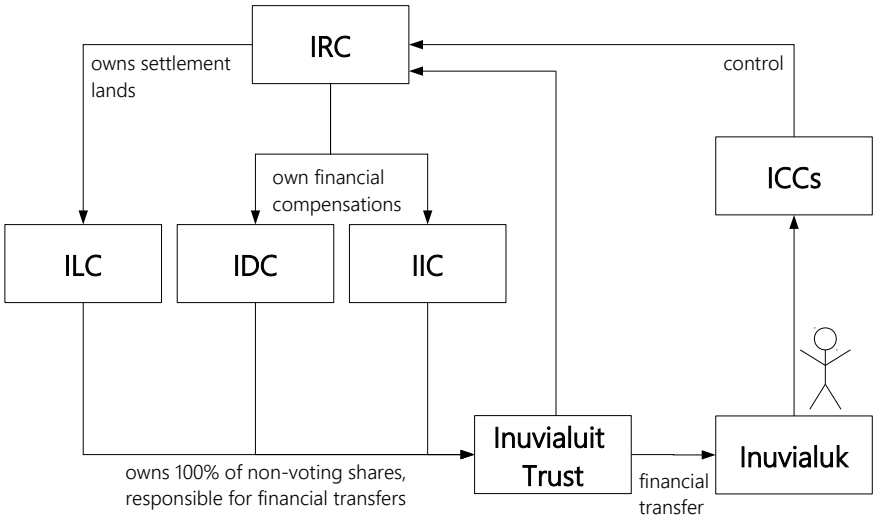


Figure 3.3.: This flowchart shows the organization of the Inuvialuit Regional Corporation (IRC). ILC = Inuvialuit Land Corporation, IDC = Inuvialuit Development Corporation, IIC = Inuvialuit Investment Corporation, ICC = Inuvialuit Community Corporation. Source: own illustration.

lands are owned by the Inuvialuit Land Corporation (ILC). Two different corporations, the Inuvialuit Development Corporation (IDC) and the Inuvialuit Investment Corporation (IIC) receive financial compensation from IRC. The IDC is responsible for industrial development in the region. The IIC is responsible to invest the received money into portfolio securities. 100% of non-voting shares belong to the Inuvialuit Trust. The Inuvialuit Trust manages financial transfers to each individual Inuvialuk. All in all the IRC is controlled by the Inuvialuit Community Corporations (ICCs), which consists of members of Inuvialuit communities in the ISR (for further explanation see figure 3.3) (Yukon Government, 2006).

Furthermore, to fulfill the harvest rights of the Inuvialuit and to manage wildlife properly, different committees were established. The most relevant committee is the Wildlife Management Advisory Council (WMAC). WMAC has six members, one member is part of the Canadian Government, two members are from the North West Territories Government and

three members have to be Inuvialuit. The entrusted tasks of WMAC are determination and recommendation of harvest quotas, to propose review and advise to the Canadian Government on any aspects regarding wildlife and preparation of a wildlife conservation and management plan for the ISR. WMAC is supported by different other committees and councils as the Fisheries Joint Management Committee, the Inuvialuit Game Council (IGC), the Inuvialuit Hunters and Trappers Committees (HTCs) and the Research Advisory Council. These committees and councils fulfill tasks to acknowledge Inuvialuit rights and propose WMAC with necessary information on the development of wildlife. Each ICC therefore has an associated HTC (Indian and Northern Affairs Canada, 1984). The closest HTC to Herschel Island Qikiqtaruk is the Aklavik Hunters and Trappers Committee (Yukon Government, 2006).

3.3.2. Management Plan

As a result of the IFA, Herschel Island Qikiqtaruk Territorial Park got its first management plan in 1987 (Yukon Government, 2006). It has been revised in 1991, 2006 and 2018. The first management plan was prepared by a joint committee, which was composed of members of the government and Inuvialuit. The revised versions are also cooperative achievements between WMAC, Aklavik HTC, IGC and governmental parties (Yukon Government, 2006; Yukon Government, 2018a). The last revision of the management plan took place in 2018 while this thesis was written. Therefore the management plan of 2006 and the management plan of 2018 are examined and will be discussed later.

The main focus of the management plan of 2006 is to *"conserve the islands natural and heritage resources, while respecting Inuvialuit rights"* (Yukon Government, 2006, p. 2, para. 2). It focuses on four main categories, each with its distinctive management recommendations:

1. ecosystems, biodiversity and wildlife
2. heritage and culture

3. visitor use
4. economic benefits

The vision of the management plan of 2018 is that

> *"Herschel Island-Qikiqtaruk is a place of traditional use, connection to the land, and where knowledge is shared with future generations. As a unique Arctic island, Herschel Island Qikiqtaruk Territorial Park has a special role as a gathering place where Inuvialuit welcome and benefit from visitors experiencing, learning about and celebrating the island and its cultural and natural history. Those who manage and take care of the island work together to fulfill the Elders' vision of Qikiqtaruk as a park to protect and sustain the ecological integrity and heritage values for generations to come"* (Yukon Government, 2018a, p. 6, para. 1).

It focuses on the same four categories as the management plan from 2006 for the implementation of the vision.

3.4. Tourism

> *"The commercial organization and operation of holidays and visits to places of interest."* (https://en.oxforddictionaries.com/definition/tourism; 11.06.2019; 18:36 Uhr)

3.4.1. Last Chance Tourism

The global tourism demand is on a steady rise (Stewart et al., 2017; Stewart et al., 2009; UNWTO, 2018) and most visitors like to visit pristine and wild places (Lemelin et al., 2010; Hall and Saarinen, 2010; Stewart et al., 2009). There is an increasing thirst to experience

changing and endangered landscapes, animals and plants before they finally vanish. This kind of tourism is called Last Chance Tourism (LCT) (Lemelin et al., 2010).

In general LCT is seen as a double-edged sword for the traveled regions (Lemelin et al., 2010; Dawson et al., 2011). An increase in tourism activity will add stress to already impacted and threatened systems (Lemelin et al., 2010) and is not only added locally. The complex global interaction of leisure travel to distant destinations, like CO_2 emissions, building of infrastructure and production of waste, sets stress to the whole environment (Dawson et al., 2011). On the other hand travelers might act as environmental ambassadors against climate change (Dawson et al., 2011). As the Arctic is known as the world's last great wilderness, for its scenery landscape and the endangered polar bears, it has become a favorite destination for last chance tourists (Lemelin et al., 2010; Stewart et al., 2005).

3.4.2. Arctic Tourism

Tourism in the Arctic has historically developed from the intention to find the Northwest Passage. Nowadays, people like the perception of being explorers and adventurers visiting unseen places (Dawson et al., 2011). As most of the Arctic is characterized by remoteness and pristine wilderness, the infrastructure for tourism is present, but less developed than in other touristic regions (Lasserre and Têtu, 2015). Commonly, Arctic tourism is characterized by its difficulty to access sites of interest: geographical as well as financial; due to the fragile environment where it takes place; its little developed infrastructure and a high seasonality (Hall and Saarinen, 2010).

Nevertheless, because of its substantial economic income, even compared to energy and mineral exploitation, tourism is developing as a major industry in the Arctic. It is already a significant part of Yukon Territories economy and of growing interest to northern governments (Hall and Saarinen, 2010).

Figure 3.4.: This shows the MS Hanseatic, an expedition-style cruise ship vessel operated by Hapag Lloyd, in Thetis Bay opposite the main camp on Herschel Island Qikiqtaruk. Source: Researcher of AWI, 2012

As the ocean is the fastest increasing global tourism sector (Stewart et al., 2009), the amount of cruise ship tours has grown steadily (Stewart et al., 2009; Stewart and Draper, 2006). Cruise ship operators serve most of the scenic landscape and offer tours to remote places like Antarctica and the Arctic (Lasserre and Têtu, 2015; Blankholm, 2009). In 1984 the first cruise ship MV Explorer navigated through the Northwest Passage (Stewart et al., 2009). Since then the amount of cruise ships in the Arctic continually increased and became scheduled on a regular basis (Lasserre and Têtu, 2015; Hall and Saarinen, 2010).

Still, only 11% of the Arctic waters are charted for shipping (Lasserre and Têtu, 2015) and the season is narrowed down by ice break up in July and refreezing in October (Stewart et al., 2009; de La Barre et al., 2016). Even though, the extent of polar ice has decreased (Blankholm, 2009), cruise ship operators are highly dependent on weather and ice conditions (personal communication with R.Gordon; Stewart et al., 2009) as well as on seasonal variations (Hall and Saarinen, 2010). If ice coverage melted further the Canadian Arctic might become a major cruise ship highway (Lasserre and Têtu, 2015).

In addition, the tourism industry in the Arctic is highly fragmented (Landorf, 2009). As the Arctic is a region managed by eight different countries (Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, USA), each country developed its own tourism management strategy (Hall and Saarinen, 2010). Until now, no international management and monitoring strategies are present (Stewart et al., 2009) and collecting data from all countries is difficult (Stewart et al., 2005). The Canadian Arctic still misses a holistic approach to measure tourism activity. Observation is mostly scattered across many organizations and shipping is not an integral part of observation (de La Barre et al., 2016). Due to this lack of strong regulations and missing infrastructure, many tour operators are not likely to expand in Canada (Lasserre and Têtu, 2015).

Still, the modern possibilities for visits are diverse and range from flights and snowmobile adventures, to cruise ship tours and individual hikes.

3.4.3. Tourism on Herschel Island

The first settlement on Herschel Island Qikiqtaruk dates back to 1200 AD. It has served as part of an international trading route between indigenous people from the western Canadian Arctic and Russia or China. Before establishing Herschel Island Qikiqtaruk Territorial Park under the IFA, the island has been a harbor for whalers and a trading point of arctic fox and seal fur. Until the 20th century the settlement was continuously inhabited by Inuvialuit and other user groups (see figure 3.5, p.32) (Burn, 2012).

Since the establishment of the Herschel Island Qikiqtaruk Territorial Park the amount of visitors is monitored (see figure 5.1, p.40). The monitoring program breaks down visitors in five visitor groups (see table 3.1 for further description, p.30).

As one of the main goals of the park's establishment is to maintain the wilderness characteristics of Herschel Island Qikiqtaruk, visitors need to obtain a park permit to visit the

island. The only excepted group are Inuvialuit/Inupiat visitors. All other visitors are informed before their visit and guided and supervised on the island by park rangers (Yukon Government, 2006; Yukon Government, 2018a).

Table 3.1.: Summary of visitor profile categories to Herschel Island Qikiqtaruk Territorial Park. The visitor groups are derived from the Herschel Island cruise ship monitoring program and mirror the actual user groups of the island.

Visitor group	**Description**
Cruise ship visitors	Persons arriving by large cruise ship vessels. The large vessels will anchor close to the island and groups of 15-20 people will be shipped to the island by zodiacs. In the years 2005-2016 no cruise ship visitors stayed over night on Herschel island.
Inuvialuit/Inupiat	Inuvialuit/Inupiat visitors are members of indigenous communities. They often visit the island for traditional use as hunting and fishing. Some conduct Elder-Youth-programs to impart traditional knowledge.
Governmental visitors	Persons from the park administration of Yukon. They visit the island for different purposes, sometimes to monitor the conditions of the natural and cultural heritage and/or for training purposes.
Tourists	The visitor group tourists is a compilation of all persons traveling to the island not fitting in one of the other groups. Those visitors often arrive by small sailing vessels in the summer or by snowmobile in winter. Only a few attain the island via helicopter.

Researchers	With the establishment of the park, the monitoring and exploration of the environment of Herschel Island for a better understanding of the ecological interrelations became a key goal. This focus is fulfilled by diverse international cooperation with research institutes.

3.5. UNESCO and World Heritage

The United Nations Educational Scientific and Cultural Organisation (UNESCO) was founded in 1944 in the context of World War II by the United Nations (Meskell, 2013; Ryan and Silvanto, 2010). This internationally recognized organization passed the Convention Concerning the Protection of the World's Cultural and Natural Heritage (Convention) in 1974. The Convention aims to safeguard natural and cultural heritage sites of outstanding universal value for mankind (UNESCO, 1972). UNESCO still remains the most important international organization in protecting heritage sites with 193 nations that have signed and ratified the Convention (Meskell, 2013; Conradin and Hammer, 2016).

The Convention allows participating nations to nominate sites of historic, cultural or natural value for humankind in their country (UNESCO, 1972). Afterwards a committee and advisory bodies evaluate if the site is worth the inscription on the World Heritage List (UNESCO, 1972). With inscription sites gain a legal status for protection (Ryan and Silvanto, 2010). Contingent on the nation the legal status can be helpful for sites to gain a broader acceptance and relevant assistance in conservation issues (Frey and Steiner, 2011; Jha, 2005).

UNESCO expects each inscribed site to have a management plan. Depending on actual management sites might have to implement additional strategies for safeguarding their heritage after inscription (UNESCO, 1972).

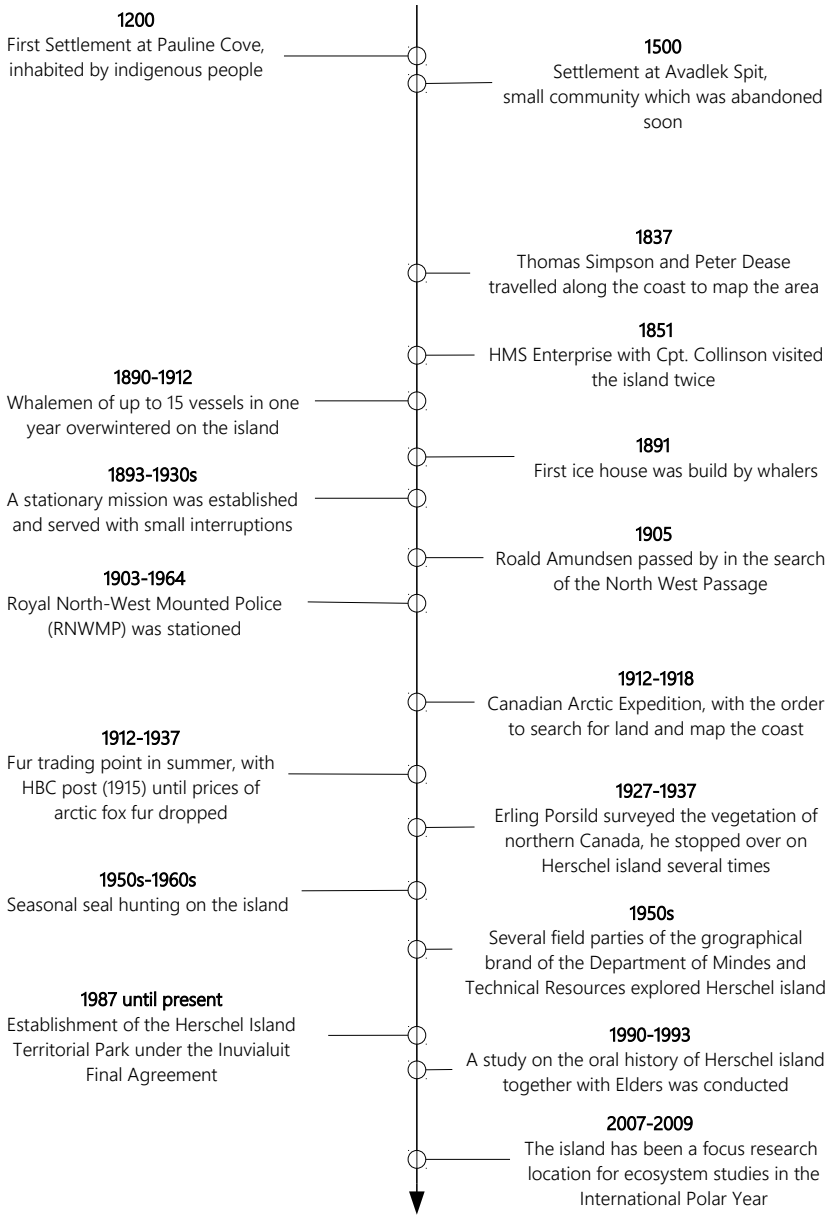


Figure 3.5.: Time line of inhabitants and visitors to Herschel Island Qikiqtaruk derived from Burn (2012). This abbreviated version of mentioned inhabitants and visitors contains the presumably most influential inhabitants and visits to Herschel Island Qikiqtaruk.

Canada is part of UNESCO since November 4th, 1946 and ratified the Convention on July 23rd, 1976. The country has been four times a member of the World Heritage Committee and exhibits 19 World Heritage Sites (UNESCO World Heritage Centre, 2004). Since 2004, Herschel Island Qikiqtaruk is inscribed on the tentative list of UNESCO, together with the Canadian National Parks Ivvavik and Vuntut, to become a cultural and natural World Heritage Site. The three inscribed parks account for 15 500 km^2 of the northern Yukon Coastal Plain. They preserve a broad natural and cultural heritage as part of the ISR (see subsection 3.3.1, p.23) (UNESCO World Heritage Centre, 2004).

4. Methods

This study is not based on new empirical evidence, but rather on a thorough literature review and data mining focused on cruise tourism in the Arctic, Herschel Island Qikiqtaruk Territorial Park, the World Heritage Site process and vegetation impact associated with small anthropogenic disturbances such as trampling. The conducted methods are outlined in the sections below. Several other methods and datasets were used in the early stages of this thesis but are not included in the analysis, because the results were not conclusive. An overview of used datasets is provided in appendix A.1.

4.1. Development of Number of Visitors

The number of tourists is monitored by park rangers and the Yukon Territory Government and collated in the year-end reports of the head ranger. The collated numbers have been partly published by Yukon Parks in the Herschel Island Visitation Synopsis 2016 from C. Eckert, the management plan of 2006, the management plan of 2018 and the ecological monitoring report of 2012. Other numbers were obtained from B. Riley from the Tourism and Culture branch of the Yukon Territory Government.

The numbers have been combined with LibreOffice Calc Version 5.3.7.2 (The Document Foundation, 2000-2017) and were analyzed with R Version 5.3.5 (R Core Team, 2019) in the user interface R Studio Version 1.2.1335 (RStudio, 2009-2019). The bar plot() command has been used for all bar charts (see figure 5.1, p.40; figure 5.2, p.42; figure 5.3, p.42).

4.2. Vegetation Analysis

To analyze the impact of anthropogenic trampling on vegetation, it was decided to focus on the impact of the two main visitor groups: researchers and cruise ship visitors. The places visited by each group were collected, delineated and visualized in ArcMap Version 10.6 (ESRI Inc., 2018) together with the ecological classes derived from Eischeid (2015). To give a better insight of the environment on Herschel Island photographs of trails together with satellite images of surrounding areas were adapted to contextualize the visitor paths.

4.2.1. Walking Trail for Cruise Ship Tourists and Impact on Vegetation

To evaluate the sites most impacted by cruise ship visitors the usual walking trail for visits on Herschel Island was plotted with help of park rangers and researchers, who support visitor guidance. In short, the park rangers and researchers were asked to recollect the paths usually taken by cruise ship visitors when they visit the island. This path is mainly used for visitor guidance around the island and goes through most cultural heritage sites located around the Pauline Cove area. This recollected path is the best indication of paths taken by visitors but it does not mean that all visitors adhered strictly to the rules and some of them may have chosen a path of their own.

As most tourists go through the same route, the map of Eischeid (2015) with the ecological classes was used for a relation analysis between walking route length and occurring ecological classes. The examined area was clipped via ”Clip-Tool” of ArcMap for the study area. The cumulative area of each ecological class in the study area was measured with the spatial analyst tool ”Zonal-Geometry-as-Table” in order to identify ecological classes that are preferentially impacted by visitors. In a second step, the intersection of paths and the polygon feature of the ecological classes was identified and the length with geometry processing calculated. The derived data was plotted and the sector of potential over

use marked (see figure 5.5, p.44). Afterwards the impact of tourism, especially trampling on vegetation, was estimated through literature reviews, personal communication with rangers of Herschel Island Qikiqtaruk and the known condition of the ecological classes published in the literature.

4.2.2. Hot Spot Analysis of Research Impact on Vegetation

To analyze the impacted sites by researchers of Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI) a Hot Spot Analysis on the GPS and DGPS data from 2014 to 2017 was conducted. Hot Spot Analysis are used to visualize statistically significant spatial clusters by using the appearance of neighbors in a predefined distance to a distinct feature. Features which are associated with high values and surrounded by other features with high values will be determined as hot spots, while features with low values, surrounded by other features with low values will be determined as cold spots. In this study identified hot spots represent places, which are significantly more frequented by researchers than other places and identified cold spots represent places, which are significantly less frequented by researchers than other places. The rest of the places researchers go through are marked as not significant. They are neither significantly more nor less visited than other places (ESRI Inc., 2019).

The Hot Spot Analysis was conducted with ArcMap Version 10.6. First of all, the existing GPS and DGPS datasets were uploaded as new layers and overlaid with the Herschel Island satellite image from World View 3 of 2015. All GPS tracks were converted to points with the ”Feature-Vertices-to-Points” function. To analyze the spatial distribution all datasets were merged into one layer. Afterwards the points were integrated with the ”Data-Management-Tool” to snap close points. Via ”Spatial-Statistics-Tool” all events were collected and coincident points were combined. The ”Spatial-Autocorrelation” function was used to determine the distance for neighboring points and z-score for further analysis. The following Hot Spot Analysis was run with a specified distance of 275 m and a z-score of 484. The inverse

distance method was chosen as calculation method. Inverse distance as method, leads to a higher influence of nearby features to target features on calculation, than features further away.

4.2.3. Additional Insight into the Environment via Photographs

For a better insight in the local conditions of ecological classes, vegetation and environment photographs from 2015 from two impacted sites were included in this study. As there are not enough pictures with the same perspective from different years, it was not possible to conduct a visual comparison assessment, yet subjective appreciation of the pictures gives a good indication of the impacts of trampling on vegetation. The World View 3 image of 2015 was used to delineate landmarks in the landscape (see figure 5.7, p.47 and figure 5.8, p.48).

4.3. Impact on Permafrost

As the study area is located in the region of continuous permafrost (see section 3.1, p.15), hydrology is one of the most important drivers of ecosystem development and succession (Wrona et al., 2016; Walker and Walker, 1991). As vegetation relies on water supplement and nutrient avalability, which is regulated by permafrost conditions, permafrost and vegetation are in a steady, interdependent connection in the Arctic ecosystem (Wolter et al., 2016; Wrona et al., 2016). Therefore impacts of trampling and possibly resulting changes of permafrost have to be discussed in this approach. Because of limited possibilities to study trampling impacts on Herschel Island Qikiqtaruk itself, this chapter does not offer new applied results. But rather a systematic desk-based literature review of conducted research with a focus on interaction between permafrost, trampling, anthropogenic pressure and vegetation alteration in the Arctic and oral information from park rangers and researchers.

4.4. Evaluating the Effects of UNESCO

To compare the guidelines of UNESCO and the management strategies of Herschel Island Qikiqtaruk Territorial Park, the Convention and the management plans of the park were analyzed. A systematic comparison of all management regulations of the Herschel Island Qikiqtaruk management plans from 2006 and 2018 and the Convention was performed.

The distinct regulations of each management plan were excerpted and combined by their overall intentions. Afterwards the intentions were clarified and shortened to compile a distinct list of management goals (see table A.1). Those resulting management goals were used to allocate categories regarding the question of the thesis (see table 4.1 for categories). Each management goal could be allocated with more than one category. Therefore the overall number of counts overshoots the number of listed management goals. The counts were pictured with R Studio and the order radarchart() from the package fsmb (see figure 5.9, p.51).

Table 4.1.: This table amplifies the five categories which have been allocated on the clarified management goals

Category	Description
Ecology	Every management goal associated with ecology even without distinct management suggestions.
Inuvialuit/traditional	This category is associated with every management goal, that broaches the issue of traditional lifestyles and Inuvialuit rights.
Heritage	All management goals dependent on heritage, culture and historic topics like the conservation of buildings and graves.
Management focus on ecology	This category counts all management goals, that are strict management suggestions on the conservation of ecological features of the park.

Management focus on visitors	This category counts all management goals, that are strict management suggestions on the practice with visitors to the island. Visitors are all people coming to the island, regardless of their intentions.

In a second step, a counting of key terms associated with topics of each management plan (see table 4.2 for key terms) was conducted. As the management plans differ in their number of pages, the 2018 management plan was adjusted to the number of pages of the 2006 management plan, by multiplying the counts with 1.47. All counts were rounded to the next integer (see figure 5.10, p.51).

Table 4.2.: This table shows the six topics which have been associated with different key terms. These key terms have been counted in each management plan.

Topic	**Counted key terms**
Ecology	ecological, ecosystem, wildlife, conservation, natural
Inuvialuit/traditional	Inuvialuit, traditional, cultural, culture
Heritage	heritage, historic, building
UNESCO	UNESCO, world heritage
Tourism	visitor, cruise ship, cruise ship visitor, ship, tourism, tourist
Research	research, researcher, science, scientist

To further identify potential consequences of the establishment of a World Heritage Site, a literature review of potential impacts associated with UNESCO status establishment was conducted. The output was a critical appraisal of impacts of UNESCO and World Heritage site status on different regions of the Earth.

5. Results

5.1. Development of Number of Visitors

The total number of visitors to Herschel Island Qikiqtaruk Territorial Park from 1989 - 2017 ranged from 310 up to 875 visitors per year. The conducted linear regression resulted in no developmental trend in the quantity of visitors (R^2 = 0.216). In average 565 visitors arrive yearly on Herschel Island, with a standard deviation of 142 (see figure 5.1).

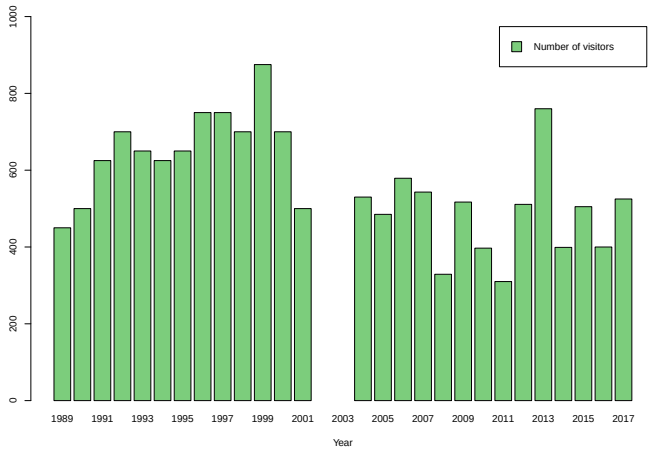


Figure 5.1.: The figure shows a bar chart of the overall number of visitors in the years from 1989 to 2017

The analyzed number of visitors of the different visitor groups do not show any statistically significant trend. Figure 5.2 demonstrates that many visitors are part of the cruise ship

visitor category and that they seem to have increased over the last years. Therefore it was decided to focus on this visitor group in the following analysis. Likewise, figure 5.3 shows that researchers (apart from the not cited rangers) spend many days on Herschel Island. They also seem to have an increasing trend and it was decided to focus on this visitor group as second part of the analysis.

5.2. Vegetation Analysis

5.2.1. Walking Trail of Cruise Ship Visitors

Map 5.4a shows the walking route close to Pauline Cove, around the settlement and towards most of the sightseeing places on Herschel Island Qikiqtaruk. The complete walking route has a length of 2415.75 m. It passes different vegetation types and four ecological classes (see figure 5.4b). Most of the cruise ship visitors are guided along this walking trail on their visit. The beginning and ending is marked with a red dot, close to the settlement, at the tip point of the coast. Usually, cruise ship visitors land there in small groups by zodiacs. While walking north towards the ice houses the visitors are guided along the coast. Then turn inwards, to the east, up the hills, where the ice houses are located. From there an inland trail leads back to the Mission house along the whalers' graves. Back at the Mission house nowadays visitors are lead along the coast back to the settlement to mitigate trampling impacts.

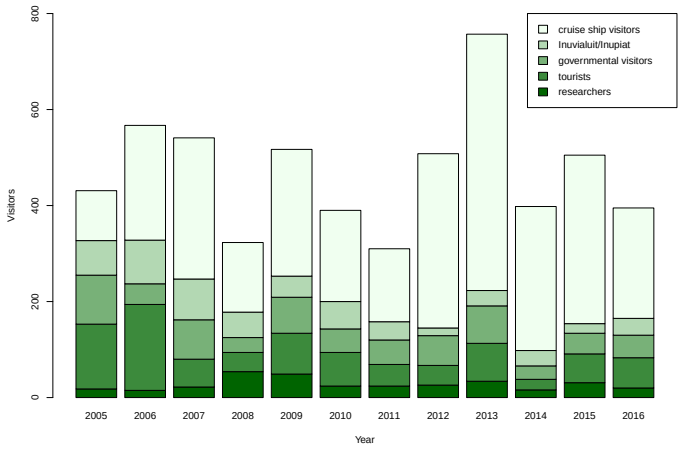


Figure 5.2.: The figure shows a stacked bar chart of the number of visitors sorted in five different categories (cruise ship visitors (light green), Inuvialuit/Inupiat visitors (medium sea green), governmental visitors (lime green), tourists (green) and researchers (dark green)) of Herschel Island in the last 10 years.

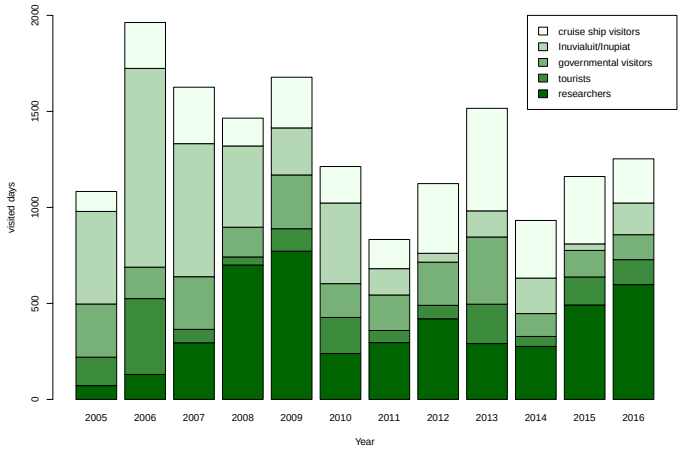
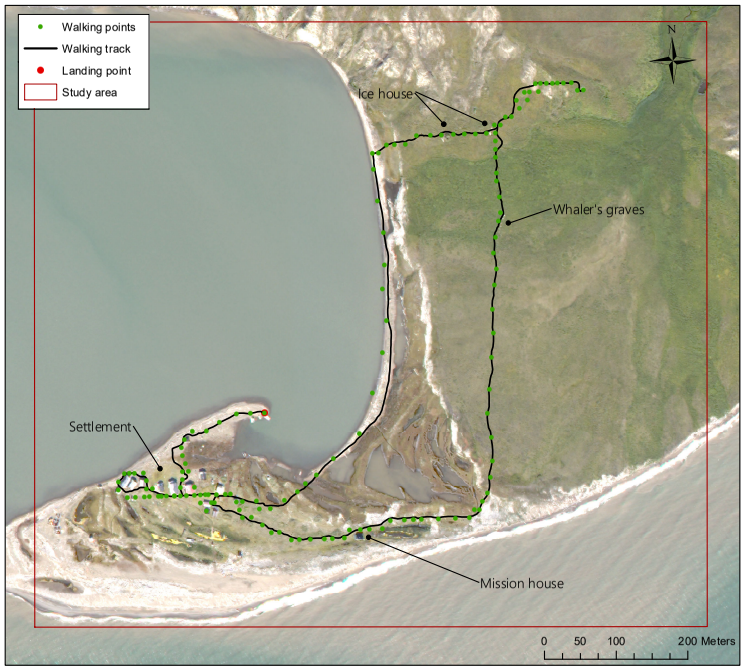
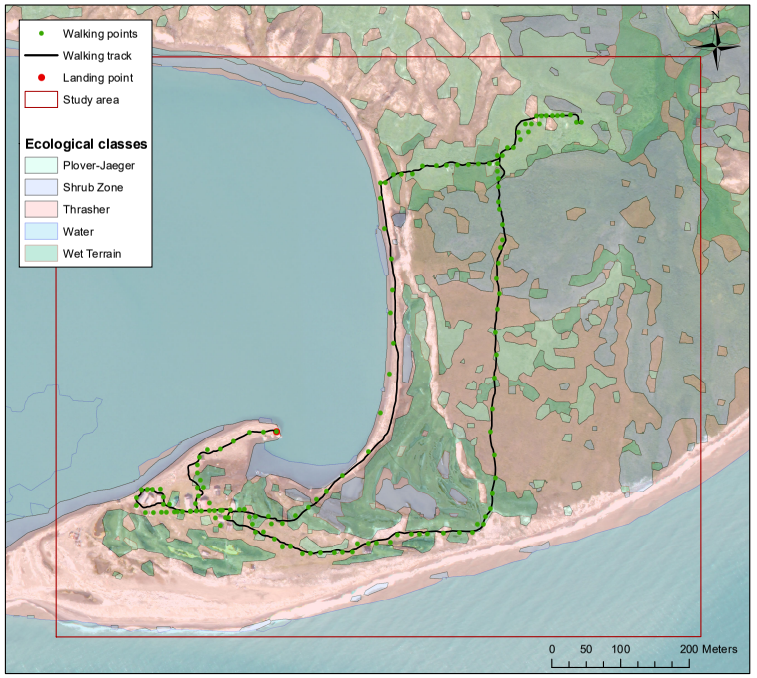


Figure 5.3.: The figure shows a stacked bar chart of the number of days visitors stayed on Herschel Island in the last 10 years. The number of visitors is sorted in five different categories (cruise ship visitors (light green), Inuvialuit/Inupiat visitors (medium sea green), governmental visitors (lime green), tourists (green) and researchers (dark green))



(a) The map shows the mainly used walking route and landing point for cruise ship tourists on Herschel Island. It was drawn from memory by H. Lantuit, supplemented with visible paths of satellite imagery and revised by R. Gordon (Senior Park Ranger)



(b) The map shows the mainly used walking route and landing point for cruise ship tourists on Herschel Island (see map 5.4a). Additionally, ecological classes (Plover-Jaeger (light green), Shrub Zone (light purple), Thrasher (light orange), Water (light blue) and Wet Terrain (dark green)) of Herschel Island are shown as a second layer, to visualize impacted classes by trampling of cruise ship visitors.

Figure 5.4.: Maps of the Walking Route of Cruise Ship Visitors on Herschel Island

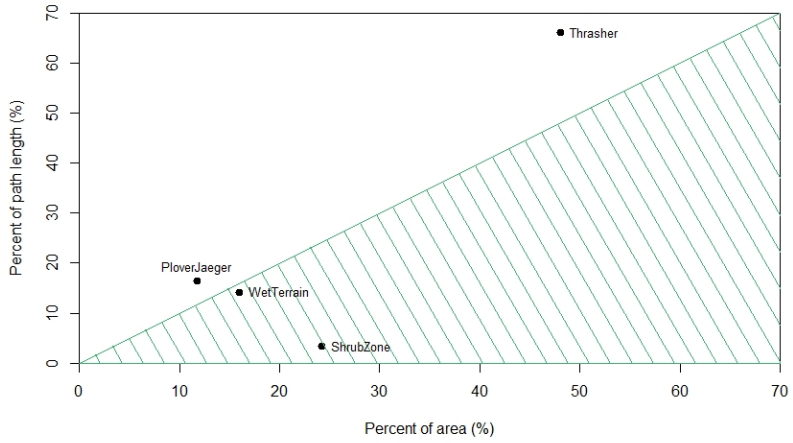


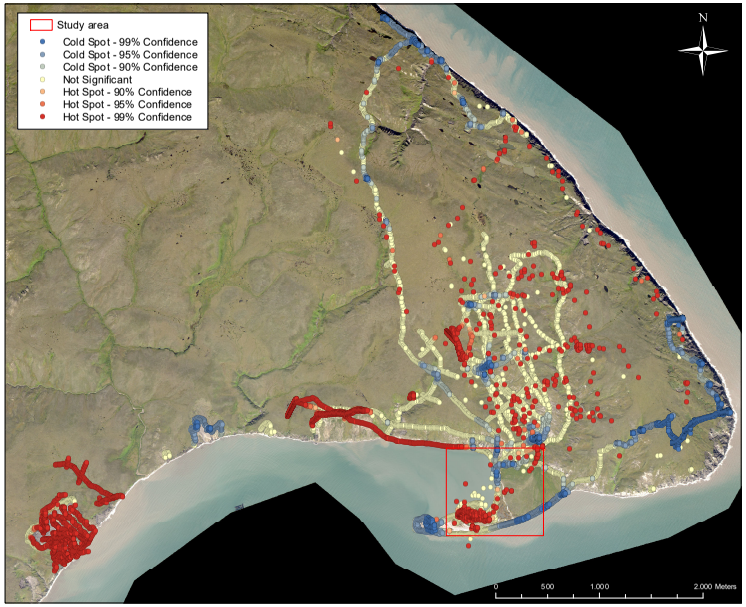
Figure 5.5.: This figure shows the percentage of the study area of the different ecological classes and the percental length of the walking route in each ecological class. The shaded section of the figure highlights the potentially not strained ecological classes, because the percent of the area with the ecological class is higher than the percent of the walking route passing them.

Map 5.4b shows the walking route combined with the determined ecological classes of Eischeid (2015). The majority of the walking route passes through regions of the ecological class Thrasher. The northern most part of the walking trail, close to the ice houses, passes through the ecological classes Plover-Jaeger and Wet Terrain (see figure 5.4a). A huge part of the eastern part of the walking route, close to the whalers graves, shows the ecological class Water, which is, compared to the map 5.4a, more likely one of the ecological classes Shrub Zone or Orca (personal communication H. Lantuit, Smith et al., 1989). The calculated percent cover of each ecological class in the study area and percent of the walking route passing through them are plotted in figure 5.5. It indicates a slight overuse of the Plover-Jaeger ecological class and a more conspicuous overuse of the Thrasher ecological class. The Shrub Zone ecological class and the Wet Terrain ecological class are instead conspicuously and slightly underused.

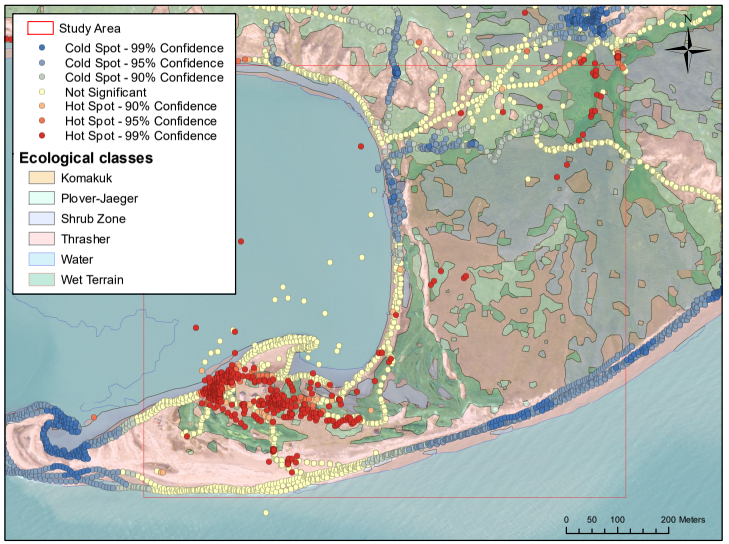
5.2.2. Hot Spots and Cold Spots of Conducted Research of AWI

Figure 5.6a shows a map with research areas of the years 2014-2017 by researchers of AWI. The conducted Hot Spot Analysis highlights the places where GPS and DGPS Data have more or less neighbors in a distinct range. These places can be interpreted as more often visited by researchers or as less often visited by researchers. The assumption that those often visited places are influenced by the higher presence of researchers, is close. Places that are less often visited might not be influenced by the low presence of researchers. The particular interest of the permafrost working group at AWI for thermokarst slumps, creeks and around Pauline Cove is represented by the analysis. Thermokarst slumps are mostly probed at the southern coast of Herschel Island, in the west of the settlement. The most reviewed creeks lay north of the settlement and are marked by criss-crossing GPS and DGPS data. As the settlement at Pauline Cove serves as base camp, many GPS and DGPS data from this area exists as well. The long distance trail to the north and along the eastern coast of Herschel Island results from the bird monitoring. The bird monitoring is regularly conducted by park rangers, but sometimes supported by researchers. Hot spots are identified at the eastern most slump, at the western creek nearby, at the southern coast north of the settlement, and between the two northern creeks. Another expectable hot spots is measured in the settlement area.

Due to the identified hot spots and cold spots, it reveals that the most impacted ecological classes are Komakuk and Wet Terrain. Most of the hot spots are located around Pauline Cove. Far less impacted are the ecological classes Plover-Jaeger and Thrasher. The majority of cold spots can be found along the southern and eastern coast, as well as up north at the ice houses. These sites are dominated by Wet Terrain and Plover-Jaeger.



(a) This map shows the overall region on Herschel Island in which researchers of AWI conducted their research in the years from 2014-2017. After compilation of the GPS and DGPS Data a Hot Spot Analysis was run (see *4.2 Vegetation Analysis* for further explanation). The blueish points show cold spots, which are places that are not often visited and the redish points show hot spots, which are places that are most often visited by the researchers. The yellow points are places without any significant visitor use due to research activities.

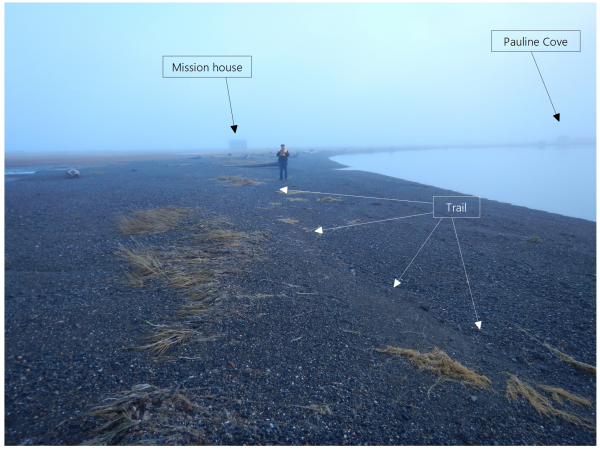


(b) This map shows the study area in the same extent as for the cruise ship visitors. It is a scaled part of the map 5.6a with the Hot Spot Analysis of the research areas on Herschel Island overlain by the ecological classes of I. Eischeid (Eischeid, 2015). The cold spots (blue points) indicate less often visited places, while the hot spots (red points) indicate more often visited places. The occurring ecological classes are displayed by light colors: Komakuk (yellow), Plover-Jaeger (light green), Shrub Zone (light purple), Thrasher (light orange), Water (light blue) and Wet Terrain (dark green).

Figure 5.6.: Maps of Research Activities of AWI on Herschel Island

5.2.3. Additional Insight into the Environment via Photographs

As a vegetation analysis from high-definition satellite images did not show any results due to the resolution, it was decided to give an imprint of the sites by photographs. The following pictures each show a site of the walking route and the accompanying satellite image of the photograph location. Figure 5.7 shows the development of a trail in the steady changing coastal environment. The trail is part of the cruise ship visitors walking tour along the beach towards the ice houses. As at the beach is not much vegetation, the trail development should not result in high impacts on vegetation.



(a) This photograph resulted from a trail inventory by the park rangers 2015. It shows the developed path at the beach from the ice houses back towards Pauline Cove. The landmarks of the path are highlighted with white arrows, while landmarks for orientation are marked with black arrows. Source: R. Gordon, 2015

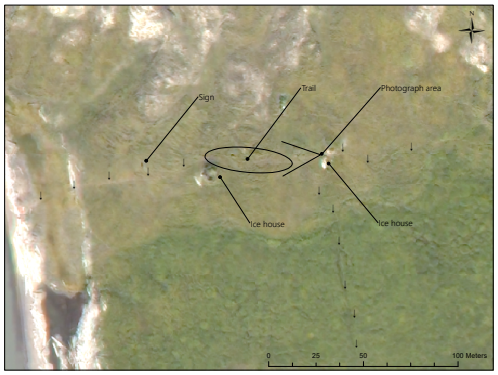
(b) This figure shows a satellite image of the location of the foreseen photograph. The satellite image does not show any evidence of the developed path. The landmarks for orientation are marked with name posts and the area where the photograph was taken is indicated by a black rectangle.

Figure 5.7.: Visual Assessment of Trail Inventory at the Beach, 2015

Figure 5.8 shows the development of a trail in the environment around the ice houses. The vegetation is dominated by Plover-Jaeger and Wet Terrain ecological classes. A distinct trail has developed and meanders through the ice houses. The vegetation on the trail is

flattened and shows small patches of exposed soil. This trail does probably not recover over winter.

(a) This photograph resulted from a trail inventory by the park rangers 2015. It shows the developed path at the ice houses towards the coast. The landmarks of the path are highlighted with white arrows, while landmarks for orientation are marked with black arrows.Source: R. Gordon, 2015



(b) This figure shows a satellite image of the location of the foreseen photograph. The satellite image does only show slight evidence of the developed path. The landmarks for orientation are marked with name posts, the area of the trail is indicated by a black circle and the area where the photograph was taken is indicated by a black rectangle.

Figure 5.8.: Visual Assessment of Trail Inventory at the Ice Houses, 2015

5.3. Comparison of UNESCO Guidelines and the Herschel Island Qikiqtaruk Territorial Park Management Plans from 2006 and 2018

The comparison of the UNESCO guidelines and the Herschel Island Qikiqtaruk Territorial Park management plans from 2006 and 2018 is elaborately shown in the section A.2 in the appendix.

The UNESCO guidelines are supposed to fit every World Heritage Site and resultant are pretty much general. They demand holistic and comprehensive management approaches for the World Heritage Sites (UNESCO, 2017). The comparison identified, that all of the detected main demands of the UNESCO guidelines regarding Herschel Island are fulfilled by the detailed management suggestions of Herschel Island Qikiqtaruk Territorial Park management plans. The *"long-term legislative, regulatory, institutional and/or traditional protection and management"* (UNESCO, 2017, p. 21, para. 97) is already overachieved by the IFA and the correspondent management of the ISR. Also no conflicting regulations have been identified between the IFA and UNESCO guidelines (see subsection 3.3.1). The financial regulation of the IRC stays untouched from the UNESCO guidelines and also does the sustainable harvesting for traditional use regulated by WMAC. With the ongoing extensive ecological monitoring program the request for a thorough measurement is satisfied in this field. As park management is supposed to report yearly to the ISR, a report every six years to UNESCO should be manageable. The implementation of conservation of the natural and cultural heritage is comprehensively designed and the protection is implemented through distinct management instructions.

The comparison between the two management plans, is shown in the two radarcharts with the key term and category numbers. The slightly different balances of the two management plans can be perceived (see figure 5.9 and 5.10). Figure 5.9 displays the counts of each category of the management goals. It is clearly visible, that the management plan of

2018 has more categories associated with the management focus on visitors and the Inuvialuit/traditional than the 2006 management plan. Whereas the management plan of 2006 has more categories associated with ecology. Relating to the heritage and management focus on ecology categories, the 2006 management plan is slightly more often associated with these categories, but the 2018 management plan shows nearly the same quantity. Figure 5.10 displays the use of key terms and shows a tendency towards more key terms in the research and tourism categories in the 2018 management plan, than from 2006. Both reveal that UNESCO has not been a highly discussed topic in the management plans.

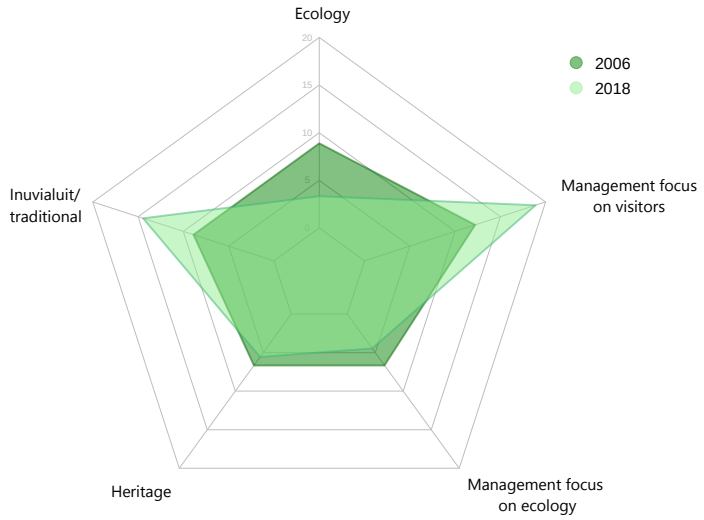


Figure 5.9.: This radarchart shows the categories and their counts of associated management goals. The light green part symbols counts of the management goals from 2018, whereas the dark green part shows the counts of the management plan from 2006.

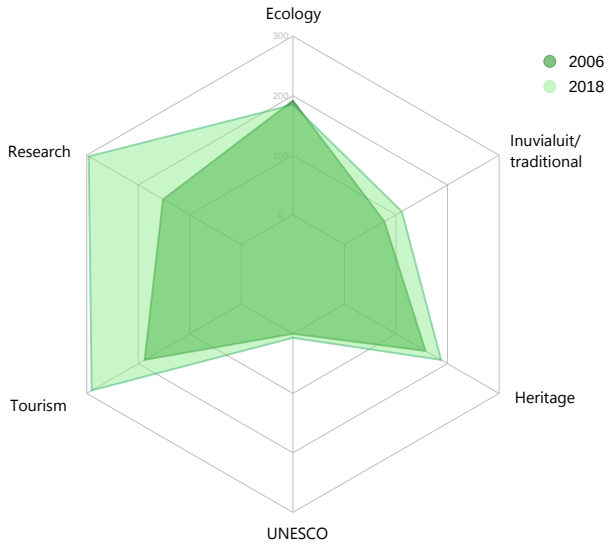


Figure 5.10.: This radarchart shows the counts of key terms in the distinct categories of each management plan. The light green part symbols the management plan from 2018, whereas the dark green part shows the management plan of 2006.

6. Discussion

The main goal of this study was to examine the potential development and impact of visitors to Herschel Island Qikiqtaruk in the statutory framework of becoming a cultural and natural World Heritage Site and to develop advising strategies to mitigate potentially arising negative impacts. To evaluate impacts of visitors vegetation alteration was used as indicator and the Herschel Island ecological classification as broader management unit. The first part of the discussion will evaluate different aspects of vegetation alteration due to trampling and compare findings with an extensive literature review to answer the first question of the aim of the study. The question on the trampling impact on permafrost will be answered by a continuative, educated guess on accompanied changes in hydrology and permafrost with vegetation alteration. The following part will answer the third question and discuss the development of numbers of visitors and traveling modalities, as well as under the perspective of becoming a World Heritage Site. The last part of the discussion will give management recommendations to consider possible interactions between the actual legal framework of the territorial park management, the outcome of the impact analysis of visitors and World Heritage Status of Herschel Island Qikiqtaruk Territorial Park to answer the fourth question. It will also give advise on the state of the art on conservation techniques to mitigate visitor impacts.

6.1. Impact of Visitors due to Trampling on Vegetation

Trail development in ecosystems has been a well studied issue in different ecosystems and protected areas (Myers-Smith, Forbes, et al., 2011; Heggenes et al., 2017; Rausch and Kershaw, 2007; Monz, 2002). Even though different types of ecosystems respond in different ways to this disturbance, trampling by animals and humans are the major factors leading to trail development (Monz, 2002; Heggenes et al., 2017). Key factors influencing the damage due to trampling are the intensity, the overall sensitivity of the environment, the succession state and the steadily changing environmental conditions (Monz, 2002). In general, Arctic ecosystems are especially sensitive (Cray and Pollard, 2018; Tolvanen and Kangas, 2016) and characterized by a low vegetation growth (Becker, Pollard, and Kardol, 2016; Rausch and Kershaw, 2007). Only wet habitats are highly resilient, whereas revegetation in dry habitats is slow (Myers-Smith, Forbes, et al., 2011; Rausch and Kershaw, 2007). Both habitats have been shown to be easily damageable (Tolvanen and Kangas, 2016). To analyze the impact of visitors on Herschel Island, we focus on alterations through human use intensity and sensitivity of ecological classes.

6.1.1. Impact Dependent on Ecological Classes

As previously stated, Figure 5.4b (p.43) shows that the path for cruise ship visitors leads through the ecological classes Plover-Jaeger, Thrasher, Wet Terrain and Shrub Zone. In the same study area, researchers pass the same ecological classes (see figure 5.6b, p.46). The characteristics of each of the impacted ecological classes are described in detail in section 3.2 (p.16).

As transitional class, the Plover-Jaeger class is especially sensitive to disturbances (Smith et al., 1989). Smith et al. (1989) already mentioned that the Plover-Jaeger class will not be impacted by foot traffic only in the driest month of the year. It can be suggested that trail development in this area is likely to occur, particularly due to the slight overuse by

cruise ship visitors (see figure 5.5, p.44). Additionally, slumping is a usual phenomenon in this ecological class and trails will be especially exposed to it (Smith et al., 1989). As before stated, wet habitats like the Plover-Jaeger ecological class are highly resilient (Forbes et al., 2001), but also most damageable (Tolvanen and Kangas, 2016).

The Thrasher class is characterized by its steady changes due to cryoturbation (Smith et al., 1989). Therefore anthropogenic disturbance resulting from trampling is less intense, than natural disturbances (Smith et al., 1989). Even though the ecological class is slightly overused by cruise ship visitors (see figure 5.5, p.44) it could be suggested, that this impact will not lead to any significant vegetation alteration other than the natural. Anyhow, disturbed areas are known to be difficult to revegetate (Rausch and Kershaw, 2007; Forbes et al., 2001).

By comparison between the GIS data for the ecological classes of the study site and pictures of the whalers graves and ice houses, it is ikely that most of the satellite identified Thrasher and Water ecological classes in the center of the study site have to be reclassified as Orca and Komakuk ecological classes (personal communication with H. Lantuit, Smith et al., 1989). The Orca ecological class is only present at the two alluvial fans on Herschel Island, one of them beginning behind the settlement area (Smith et al., 1989). Smith et al. (1989) already suggested not to overuse the area. Due to its high moisture content walking is difficult and establishing board walks is recommended (Smith et al., 1989).

The Komakuk ecological class is the most common class on Herschel Island and the associated vegetation types are seen as climax vegetation (Smith et al., 1989). Anyhow, the ecological class is not commonly identified by Eischeid (2015) at the study site (see figure 5.4b, p.43 and figure 5.6b, p.46). Neither cruise ship tourists nor researchers are passing a Komakuk site, except for the area close to the whalers graves (personal communication H. Lantuit). In general this ecological class is assumed to withstand slight foot traffic, but is still seen as sensitive to disturbance and especially thaw sensitive (Smith et al., 1989). As *Dryas integrifolia* is moderately present in this ecological class, this might be an indicator for good revegetation capacities (Rausch and Kershaw, 2007).

The Wet Terrain ecological class is flooded on a regular basis and therefore tends to accumulate a thick organic layer (Eischeid, 2015). It is slightly underused by cruise ship visitors compared to the amount of occurrence in the study area (see figure 5.5, p.44). As the name of the ecological class assumes: it is a wet habitat. It does not sustain major foot traffic (Tolvanen and Kangas, 2016) and changes in surface vegetation might induce major shifts in the hydrology of the site (Wolter et al., 2016).

The Shrub Zone ecological class is characterized by dense shrubs, mostly *Salix richardsonii* (Eischeid, 2015). Disturbances might be key drivers of shrub expansion in the Arctic (Myers-Smith, Hik, et al., 2011), but even without disturbances shrubs proliferate in these ecosystems (Epstein, Myers-Smith, and Walker, 2013). Especially shrubs can have radical impacts on the structure of the Arctic ecosystem. By formation of a dense cover, they influence snow trapping, ground heat fluxes, evapotranspiration and albedo (Myers-Smith, Forbes, et al., 2011). The alteration of hydrologic and nutrient cycles, as well as temperature changes, will lead to vegetation community changes (Myers-Smith, Forbes, et al., 2011; Epstein et al., 2013; Bjorkman et al., 2019).

Most of these ecological classes are associated with the plant species *Dryas integrifolia*, *Arctagrostis latifolia*, *Salix arctica* and *Salix reticulata* (for further details on associated plant species see table A.2).

Dryas integrifolia has been identified by Rausch and Kershaw (2007) as plant species with high revegetation potential and ability. They suggest that *D. integrifolia* might possibly cover extensive areas if there is enough time for revegetation after disturbances. Depending on the subspecies (*D. integrifolia ssp. integrifolia* or *D. integrifolia ssp. sylvatica*), *D. integrifolia ssp. sylavatica* might be an intense pioneer species in rocky or gravelly places, which are often associated with recently disturbed sites (compare subsection 3.2.1), but is less common in tundra ecosystem due to its low competition abililty in the northern climate (Cody, 1996). Cray and Pollard (2018) in contrast analyzed *D. integrifolia* as a species not inhabiting recently disturbed areas, but being commonly present in undisturbed places on Herschel Island.

Arctagrostis latifolia has increased in cover from 1% to >5% from 1986-1999 on Herschel Island (Kennedy, Smith, and Cooley, 2001). It has been measured to increase around 1-5% in cover after disturbance, which is seen as vegetation succession (Myers-Smith, Hik, et al., 2011). This common grass quickly responds to nutrient availability and has changed the appearance of the Arctic *Willow/Dryas-Vetch* Vegetation Type (VT) (Kennedy et al., 2001). It is therefore likely to proliferate further as disturbances tend to shortly increase the amount of available nutrients (see section 6.2, p.60).

Salix arctica is a common species in disturbed areas (Cray and Pollard, 2018). It produces high amounts of seeds and is therefore a highly spreading species (Cray and Pollard, 2018). It easily revegetates (Rausch and Kershaw, 2007) and is adapted to invade under changing conditions (Myers-Smith, Hik, et al., 2011). *S. arctica* is occurring in different habitats throughout the tundra environment (Cody, 1996). Many studies (Myers-Smith, Hik, et al., 2011; Epstein et al., 2013; Myers-Smith, Forbes, et al., 2011; Wolter et al., 2016) assume spreading of shrubs, especially *Salix spp.*, in the Arctic following disturbances and therefore shrubs likely benefit from anthropogenic trampling disturbances.

Besides vascular plant species, bryophytes and lichen also occur frequently on Herschel Island (Burn, 2012). Both prefer undisturbed sites (Stewart et al., 2017). If bryophytes are lost, evapotranspiration and ground heat flux might rise, which would alter the hydrologic regime (Bjorkman et al., 2019). The recovery of lichen after disturbance is not yet clarified. Heggenes et al. (2017) e.g. showed that the resilience of lichen depends on their humidity, while Monz (2002) could not identify any recovery of lichen after disturbance. Therefore sites with lichen should be avoided for any anthropogenic activities.

As far as we could figure out, there is no concrete monitoring on plant species and ecological classes with special focus on visitor impact conducted (personal communication with R. Gordon, see A.4). Such a monitoring might be helpful to evaluate, which ecological classes and plant species are impacted by visitors and which areas are especially sensitive to disturbance.

(a) This photograph shows a small research group walking towards their study site. The researchers walk apart from each other, randomly dispersed in the environment. Photographer: Jade Falardeau, University UQAM, Montreal, 2018.

(b) This photograph was taken by park rangers for the cruise ship visitor monitoring and shows a large group walking behind the tour guide. The visitors walk on a trail one behind another. Source: Gordon and Eckert (2013); Photographer: LeeJohn Meyook, Date: 10/08/2013

Figure 6.1.: Photographs of Researchers and Cruise Ship Visitors to Herschel Island

6.1.2. Impact Dependent on Intensity of Trampling

Recent studies that discuss trampling intensity quantify the intensities by counted numbers of passes on distinct vegetation patches (Monz, 2002; O'Neill et al., 2015) or differ between the way of locomotion (e.g. horse riding, hiking, camping) (O'Neill et al., 2013; Tolvanen and Kangas, 2016; Forbes et al., 2001). As no quantitative studies on the amount of visitors walking on distinct trails and the resulting impact were conducted, it is only possible to estimate the intensity. After personal communication with H. Lantuit and R. Gordon (see appendix A.4) it was decided to assume the impact of cruise ship visitors as result of high intensity trampling and as a short term influence (Historic Sites, Tourism and Culture of Yukon Government, 2013; Gordon and Eckert, 2013). Whereas impact of the researchers is assumed to be a result of low intensity trampling and a long term influence due to their recurrent visits.

Monz (2002) conducted a study, which was found to be highly relevant for this study. They

monitored the impact of trampling intensities on a dryas tundra Vegetation Type (VT) and a tussock tundra VT, which are both comparable to common vegetation on Herschel Island, for a period of four years. They figured out that initial disturbance lead to the highest changes in vegetation cover. But vegetation plots with passes of 25-75 times have been fully recovered in both VTs, whereas plots with 500 passes still show a visible loss of vegetation cover after 4 years. Anyhow, more than 200 passes resulted in a vegetation cover loss of approximately 50% in both VTs. Overall the tussock tundra VT had a lower resistance and higher resilience than the dryas tundra VT. Instead, the dryas tundra VT was more resistant with a lower resilience. They suggest that the dryas tundra VT is more likely to tolerate moderate use. Cruise ship visitors to Herschel Island Qikiqtaruk Territorial Park account at one visit for approximately 70-230 visitors, which pass the same area. These passings are assumed to be comparable of 200 passings as described in Monz (2002). Therefore they are supposed to result in the same amount of vegetation loss.

Many studies support the results of Monz (2002) that the impact of trampling, independent of its intensity, is highest at the initial state (O'Neill et al., 2015; Tolvanen and Kangas, 2016; Forbes et al., 2001) and once trails have been established trampling is supposed to be limited to them (O'Neill et al., 2015; O'Neill et al., 2013). These findings go along with the results of the cruise ship monitoring in 2013 on Herschel Island Qikiqtaruk Territorial Park, where trails developed after cruise ship visits (Historic Sites, Tourism and Culture of Yukon Government, 2013; Gordon and Eckert, 2013).

Myers–Smith et al. (2019) presume that low intensity trampling of researchers around their long-time vegetation around the plots might have impacted the vegetation plots over time. Other studies suggest a widespread trampling with low intensities would lead to less impact (Monz, 2002; O'Neill et al., 2013) and should be preferred, instead of walking in a line (O'Neill et al., 2013). For highly resilient areas on Herschel Island, spreading might be a good alternative and is already practiced (personal communication R. Gordon).

Once trails are developed, Myers-Smith, Forbes, et al. (2011) underline two outcomes: 1. the trails will lead to further damaged biomass and a reduced vegetation cover or 2. the trails

will provide suitable habitats for the recruitment of vegetation. In addition it is known that microtopography plays an important role in vegetation dynamics (Wolter et al., 2016) and trampling possibly creates such microsites (Myers-Smith, Forbes, et al., 2011).

Overall it can be concluded, that the impact is more severe with rising intensities of trampling. But still, the resulting amount of impact depends on vegetation type and the resistance as well as the resilience of the impacted vegetation types.

6.1.3. Impact of Trampling on Vegetation Compared to Other Disturbances

Anthropogenic disturbances in the Arctic occur since the first settlements. Those disturbances mostly result from the many activities around small villages (Walker and Walker, 1991). At some sites housing has been shown to alter nutrient cycling, mostly generating a higher availability of nitrogen and phosphates (Forbes et al., 2001).

With World War II and the early oil and gas exploration, disturbances from industrialized population prevail. Those disturbances are still visible at some places, as major infrastructure (like roads, villages, etc.) needs more than 100 years to fully recover (Walker and Walker, 1991). At the same time Herschel Island Qikiqtaruk has become a frequently visited place by different stakeholders (see figure 3.5, p.32). Nowadays, oil and gas explorations are still present around Herschel Island and add stress to the environment (Yukon Government, 2018a).

Critical for impacts is the season of disturbance occurrence, as in winter most of the vegetation is covered and sheltered by snow (Forbes et al., 2001). Despite it is difficult to determine concrete disturbances (Walker and Walker, 1991), most of them are more intense and cover larger areas than in the past (Walker and Walker, 1991; Forbes et al., 2001). Also full vegetation recovery is not often measured, at least a functional recovery with changed vegetation composition might occur after succession (Walker and Walker, 1991).

In general impact of any type of disturbance is dependent on a few key factors: first of all, the original vegetation type determines the buried seed bank and the availability of native seeds from adjacent sites; the moisture and biogeochemical cycle of the site impact the succession ability of available seeds; and type, frequency and severity of disturbance influence the possibilities of succession (Walker and Walker, 1991). Anyhow, Forbes et al. (2001) mentioned that disturbed sites might be patches of resources for the next years.

6.2. Impact of Visitors due to Trampling on Permafrost

Tolvanen and Kangas (2016) concluded long-term trampling is likely to induce alterations of physical and hydrologic properties of the site and any disturbance of the soil surface is assumed to impact the permafrost table underneath (Campbell et al., 1994; O'Neill et al., 2015; Becker et al., 2016; Forbes et al., 2001; Tomczyk and Ewertowski, 2010). In general, disturbances of the soil will lead to short- and long-term alteration of the on site geomorphology (Cray and Pollard, 2018), which might further lead to slumping and shrinking at the soil surface (Campbell et al., 1994). Even disturbances on a small scale with low intensity are supposed to have an immediate impact with accompanying permanent effects (Forbes et al., 2001). Trampling might also result in the loss of organic matter at the active layer (O'Neill et al., 2015; Steven et al., 2006) and compaction with rising dry bulk density (O'Neill et al., 2015; Forbes et al., 2001)

Anthropogenic activities have been shown to impact soil nutrients and their availability, e.g. organic carbon and total nitrogen storage (Obu et al., 2017). Some disturbances seem to result in increased decomposition and mineralization (Forbes et al., 2001). Becker et al. (2016) identified an increase in Ammonium (NH_4^+) and a decrease of Phosphate (P) and Potassium (K) for disturbed sites. The pH value is supposed to decrease as well (Becker et al., 2016), while undisturbed sites are usually characterized by a neutral pH (Steven et al., 2006). The generally low salinity of permafrost soils (Steven et al., 2006) will still result in a disposal of salts after disturbances (Becker et al., 2016). Myers-Smith, Hik, et al. (2011)

identified in a vegetation analysis of Herschel Island of the 20th century, that the active layer deepens and permafrost degradation is more active than before.

Additional to nutrient alteration, soil hydrology is significantly impacted by disturbances (Becker et al., 2016; Gellatly, Whalley, Gordon, and Ferguson, 1986; Wolter et al., 2016; Forbes et al., 2001; Campbell et al., 1994; Wrona et al., 2016). Forbes et al. (2001), Campbell et al. (1994) and O'Neill et al. (2015) assume a significant reduction of soil moisture after disturbance, whereas Becker et al. (2016) expects an increase in moisture content. Gellatly et al. (1986) identified an increase in soil moisture at the initial stage of disturbances due to soil compaction, which later leads to an overall decrease in moisture availability. In general, soil moisture gradients are highly influenced by soil surface conditions and disturbances might lead to a lowering of the permafrost table (Campbell et al., 1994). An increased soil moisture might also conduct to a longer lasting zero-curtain effect (Kelley and Weaver, 1969). Besides the influence of disturbance on permafrost, permafrost thaw is part of a complex interaction between vegetation composition and temperature, mediated by soil characteristics (Wrona et al., 2016; Walker and Walker, 1991; Genxu, Guangsheng, Chunjie, and Yan, 2012). Therefore, thawing of permafrost will be influenced by vegetation alteration and Genxu et al. (2012) found out that an intense degradation of vegetation in an alpine meadow environment would result in an increased active layer thickness and thawing depth. Wrona et al. (2016) concluded that thawing of permafrost will result in flooded roots, which will lead to collapsed vegetation. In conclusion the resulting hydrologic alterations from disturbance are expected to result in ecosystem alterations with associated vegetation changes and possibly climatic responses (Wrona et al., 2016; Walker and Walker, 1991).

Most distinct anthropogenic disturbances, like tracks resulting from foot or vehicle traffic, occur at a microscale basis (Walker and Walker, 1991). Tracks are seen as channels for water and soil transport, which facilitates erosion and results in rutted tracks (O'Neill et al., 2015). The track degradation is always related to intensity, type and frequency of disturbance (Gellatly et al., 1986) and therefore dependent on group size of visitors (Tomczyk

and Ewertowski, 2010).

Apart from geomorphologic alteration through trampling, trampling is assumed to have negative effects on the soil ecosystem (O'Neill et al., 2013). The microbial activity will be reduced (O'Neill et al., 2015; O'Neill et al., 2013), even at low trampling intensities (O'Neill et al., 2013). Functional ecosystems in soils exist (Steven et al., 2006) and will be altered by changed thawing events (Wrona et al., 2016). As the overall biogeochemical processes of permafrost are still underestimated and partly unexplored, implications on global processes are possible (Steven et al., 2006). Therefore anthropogenic disturbances to permafrost environments should be limited to the absolute possible minimum. Further research with a special focus on tourism development and its impacts on Canadian permafrost could become more and more important.

6.3. Visitor Development on Herschel Island

To achieve the main goal of the study and to examine the potential development and impact of visitors to Herschel Island Qikiqtaruk in the statutory framework of becoming a cultural and natural World Heritage Site, the changes in number of visitors and traveling modalities are analyzed in this chapter. The number of visitors does not show any significant trend and traveling modalities changed from former individual travels by small boats or snowmobile towards cruise ship vessels. Therefore the development of cruise ship visitors will be examined as main focus.

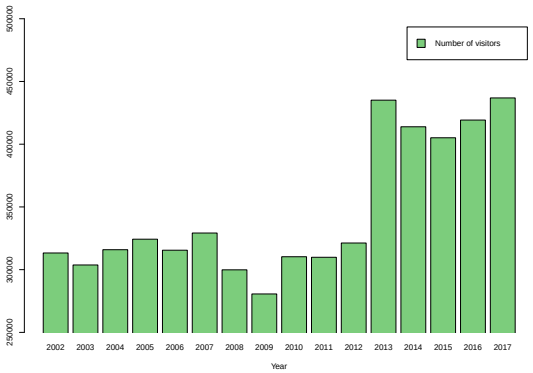
6.3.1. Development of Number of Visitors

Visits to the Arctic are highly seasonal and tourism operations on Herschel Island Qikiqtaruk Territorial Park are mostly limited to the period from May to September (Hall and

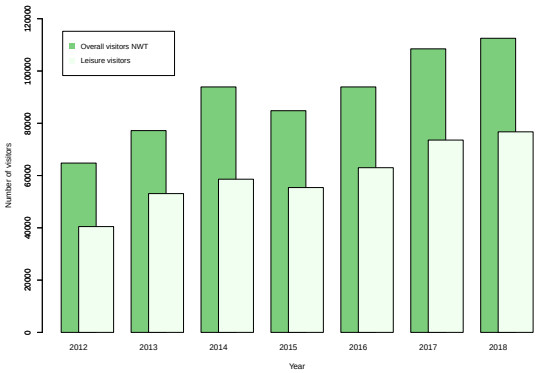
Saarinen, 2010). Often weather and other difficulties challenge operators to change their routes and visits (Stewart et al., 2009; Stewart and Draper, 2006).

Since the establishment of the Territorial Park, Herschel Island Qikiqtaruk has welcomed over 15265 visitors, with an average of 565 visitors each year. In the visitation synopsis from Eckert (2016) no significant statistical trend in visitor development was found. This has been additionally outlined before in Figure 5.1 (p.40), even though an apparently descending trend for the overall number of visitors might be assumed. This trend could possibly be explained by a decreasing trend of Inuvialuit/Inupiat, governmental and individual tourist visitors to the park. Except for the years 2007-2009, which have been declared as third International Polar Year, the number of research visitors is fairly stable (see figure 5.2, p.42). Nevertheless, the number of over night stays of researchers has steadily increased over time and reached a peak in 2009 at the end of the International Polar Year (see figure 5.3, p.42). On the other hand, the number of cruise ships arriving on Herschel Island increased over the recent years, with a high peak in 2013 (personal communication with R. Gordon, B. Riley and H. Lantuit). This peak resulted in monitoring reports of the impacts from cruise ship visitors on the natural and cultural heritage resources (Historic Sites, Tourism and Culture of Yukon Government, 2013; Gordon and Eckert, 2013).

In contrast to the findings in this study, the tourism sector of the Canadian Arctic shows a continuous increase (Hall and Saarinen, 2010; Stewart et al., 2005; Yukon Government, 2006), while it seems to be impossible to identify the concrete amount of visitors for the whole region (Stewart et al., 2005). Yukon Territory and Northwest Territories experienced a steady rise in visitors over the last decade (see figure 6.2). The amount of visitors to the Yukon Territory are derived from counts of border passing of any visitors. These counts do not indicate the purpose and length of stay, which makes them difficult to interpret for the tourism industry. Hall and Saarinen (2010) figured out, that Nunavut is visited by approximately 9300 tourists from June to October, whereof nearly 2100 are on board of cruise ships. Overall, the number of visitors of Herschel Island are supposed to be proportional to the numbers of Mackenzie Delta (Yukon Government, 2006), which belongs to



(a) The figure shows a bar chart of the number of persons crossing the border to arrive in the Yukon Territory from 2002-2017. The data is derived from Yukon Government (2012) and Yukon Government (2018b).



(b) The figure shows a grouped bar chart of the number of visitors to the Northwest Territories and outlines the amount of leisure visitors from 2011-2018. The data is derived from Government of Northwest Territories (2018) and Government of Northwest Territories (2016).

Figure 6.2.: Bar Charts of the Number of Visitors of Northwest Territories, the Beaufort Sea region and the Yukon Territory

the Beaufort Sea region.

Lemelin et al. (2010) outline, that an increase in number of visitors to Arctic landscapes might add pressure to this already impacted and sensitive habitat. Even if the effects of visitors on natural and cultural heritage are hard to measure (de La Barre et al., 2016), they have been explored in different circumstances (Stewart et al., 2005) and on Herschel Island (Historic Sites, Tourism and Culture of Yukon Government, 2013; Gordon and Eckert, 2013).

6.3.2. Development of Visitor Traveling Modalities

When distinguishing between the different visitor categories (see table 3.1, p.30), the distinction, besides the intention of the visit, is a differentiation between traveling modalities.

(a) This photograph shows a typical fixed-wing aircraft operating to Herschel Island. Source: AWI field expedition, 2014

(b) This photograph shows a helicopter operating at Herschel Island. Source: AWI field expedition, 2014

Figure 6.3.: Photographs of Aircraft Travel Modalities to Herschel Island

The two most common traveling modalities to reach the island are by aircraft or water passage.

Especially researchers and governmental visitors charter flights from Inuvik with fixed-wing aircraft or helicopter (Yukon Government, 2006; Yukon Government, 2018a). These flights need a park use permit to land on the island. Fixed-wing aircraft is restricted to land on the beach landing strip, whereas helicopter flights are under special requirements allowed to land in the wilderness zone (Yukon Government, 2018a). The majority of these flights are supportive for park operations (Yukon Government, 2018a). Researchers usually use planes to transport their equipment to the island and arrive in small groups (personal communication H. Lantuit). The amount of plane landings account for 44% of all arrivals to Herschel Island, but only for 20% of the total number of visitors from 2005-2016 (Yukon Government, 2018a).

Also around 20% of the total number of visitors is accounted by boat travelers. Boat travelers combine Inuvialuit visitors and private sailing vessels. Inuvialuit visitors often show up by motorboat from Mackenzie Delta (Yukon Government, 2018a). Private sailing vessels

Figure 6.4.: This picture shows Pauline Cove and the settlement area. In the background three fishing vessels are operating and in the front three private sailing vessels anchor. Source: George Tanski, AWI, 2017

mostly have been on their way through the northwest passage (personal communication B. Riley). At the moment they make a small proportion of visitors to the island (Yukon Government, 2018a), but tend to increase (personal communication B. Riley).

In comparison, cruise ship visits account for 4% of arrivals to the island, but for 55% of total number of visitors from 2005-2016 (Yukon Government, 2018a). As cruise ships transport about 60-120 passengers (Cooley et al., 2012) or respectively 77-230 passengers (Eckert, 2016) to a land expedition on Herschel Island, the high percent of cruise ship visitors is not astonishing anymore. Since the first cruise ship reached Herschel Island Qikiqtaruk Territorial Park in 2002 (Cooley et al., 2012) the overall number of cruise ship visitors has been shown to be fairly stable (see figure 5.2, p.42 and personal communication B. Riley). Like aircraft, cruise ships are only allowed to visit with a park permit (Yukon Government, 2018a). Due to the park permit they can be restricted for Herschel Island Qikiqtaruk Territorial Park (Yukon Government, 2018a). Though there is neither a Canadian nor an international regulation or guideline for cruise ship operations and no control is exercised (Stewart and Draper, 2006). Even though cruise ships are expected to not merely stop over

at the North coast of Canada (Stewart et al., 2009), Herschel Island has received some cruise ships in the last years (Yukon Government, 2018a). Contrary Lasserre and Têtu (2015) assume that cruise ship operators will start to increase more in destination traffic, rather than passing through the Arctic.

Anyhow, all traveling modalities are highly dependent on weather conditions (Stewart et al., 2009; Stewart and Draper, 2006; Yukon Government, 2018a). Sea ice conditions impact the possibility to anchor close enough for shore leaves to the island and sometimes more cruise ship visits are requested than show up (personal communication with B. Riley and R. Gordon). The water passage from Aklavik by motorboats is risky and also limited by sea ice conditions (Yukon Government, 2018a). Air passage from Inuvik is mostly limited by wind and the conditions of the landing strip. After storms and sudden weather changes the landing strip sometimes is unusable (Yukon Government, 2018a).

Nevertheless, the ocean is one of the most important economic branches of the tourism industry (Stewart et al., 2009; Stewart and Draper, 2006) and tourism activities are likely to expand, with associated increase in number of visitors on Herschel Island Qikiqtaruk Territorial Park.

6.3.3. Projected Visitor Development as a World Heritage Site

As mentioned before, Herschel Island Qikiqtaruk Territorial Park is on the tentative list for becoming a cultural and natural World Heritage Site together with Ivvavik National Park and Vuntut National Park since 2004. Establishing a Territorial Park in Canada has been, and still is, a political and scientific-based decision, which is often based on tradition (Cooke et al., 2016). Herschel Island Qikiqtaruk Territorial Park is no exclusion, as it was established in the context of the IFA in the ISR (Yukon Government, 2006; Yukon Government, 2018a; Burn, 2012; Indian and Northern Affairs Canada, 1984).

Inscription to the World Heritage List is mostly associated with a higher public attention (Meskell, 2013; Conradin et al., 2015; Jha, 2005; Poria et al., 2013), the increase of number of tourists (Meskell, 2013; Conradin and Hammer, 2016; Poria et al., 2013; Frey and Steiner, 2011) and further economic development (Meskell, 2013; Conradin et al., 2015; Conradin and Hammer, 2016). To inscribe a site is a highly political act, which attracts attention of various stakeholders (Frey and Steiner, 2011). Until 1980s the first priority for inscription of a site was the international recognized protection status (VanBlarcom and Kayahan, 2011; Conradin et al., 2015), whereas nowadays the socio-economic benefits sometimes outrun the protection priority (VanBlarcom and Kayahan, 2011). Still, conservation seems to be the highest motivation to inscribe on the World Heritage List (Conradin et al., 2015). Anyhow, becoming a world heritage site means the accession to an *"[...] exclusive group of particularly recommendable destinations"* (Conradin et al., 2015, p. 8, para. 2).

This in turn favors the development as touristic destination (Meskell, 2013; Frey and Steiner, 2011; Poria et al., 2013; Conradin and Hammer, 2016). Frey and Steiner (2011) figured out, that the increase of touristic visits to a site is positively related to the overall tourist visits of the country, but for already known attractions inscription would not lead to an increase. Beforehand, we have seen that the amount of visitors in the surrounding region of Herschel Island has risen in the later years (see fig 6.2, p.64), but not on Herschel Island itself (see figure 5.1, p.40). Anyhow, it is likely, that the World Heritage designation will lead to an increase of visitors to Herschel Island Qikiqtaruk. It is also assumed, that sites which have not been well-known, benefit from World Heritage designation (Frey and Steiner, 2011; Cooke et al., 2016). Nevertheless, remoteness can be a limiting factor and infrastructure has an important influence (Jha, 2005). Herschel Island Qikiqtaruk Territorial Park, in contrast, has recently experienced a change in visitor modalities (see subsection 6.3.2), which might also alter the accessibility of the site and therefore the number of tourists accessing the territorial park.

Regarding the visitor development after designation VanBlarcom and Kayahan (2011) conducted an example study. They analyzed the visitor data of a cultural World Heritage Site

(Old Town Lunenburg, Nova Scotia) before and after the site has been designated. They calculated, that the amount of visitors increased by 6.2% after designation. Comparable literature research lead them to the assumption, that a general rise in tourist visits can be expected at approximately 1-5% per year. They also reported, that 40% of surveyed sites by other researchers indicate an increase in tourist visitors. Similarly, Conradin et al. (2015) found that 57% of their analyzed sites recorded an increase in tourist visitors after inscription as World Heritage Site. In contrast Wuepper (2016) supposed that the projection of tourism development after World Heritage designation will always be debatable.

Nevertheless, the designation as a cultural and natural World Heritage Site might act as a brand for further advertising (Conradin et al., 2015; Wuepper, 2016; VanBlarcom and Kayahan, 2011; Ryan and Silvanto, 2010). Many visitors associate the World Heritage Sites with a confirmation of its importance (Ryan and Silvanto, 2010) and react positively towards the brand (Wuepper, 2016). The branding has been seen as method for conservation for a long time, which now changed to a marketing opportunity (Conradin et al., 2015). Hence, Ryan and Silvanto (2010) criticize the brand as commercialization of heritage. Anyhow, the marketing might come along with an increasing economic value of the site (Meskell, 2013). Therefore World Heritage Sites are often seen as developing agents for a sustainable progression of the region (Conradin and Hammer, 2016; Conradin et al., 2015). Which might further be followed by tensions between the conservation aspect and economic self-sufficiency of the people living close to World Heritage Sites (Romaine and Gorenflo, 2017, Ryan and Silvanto, 2010). Furthermore mismatches of the distribution of financial revenues can be found (Jha, 2005). Additionally, visitors often expect World Heritage Sites to be more expensive than comparable sites (Poria et al., 2013).

If Herschel Island Qikiqtaruk Territorial Park gets assigned a natural and cultural World Heritage Site, this might possibly have implications on the number of tourists and the economic revenue of visits. Anyhow, the involvement of Inuvialuit and Inupiat around Herschel Island Qikiqtaruk is crucial, as World Heritage Sites have been shown to possibly contribute to threat traditional lifestyles of indigenous people (Romaine and Gorenflo,

2017).

On an administrative level the comparison between UNESCO guideline and the two management plans of Herschel Island Qikiqtaruk Territorial Park did not show serious conflicting regulation approaches (see section 5.3, p.49). This supports an inscription for conservation purposes, while being aware of the potential increase in number of visitors after designation.

6.3.4. Projected Visitor Development in the Light of Global Climate Warming

Visitor development in the Arctic and therefore Herschel Island, is highly dependent on weather and sea ice conditions (Stewart and Draper, 2006; Stewart et al., 2009). Global warming is supposed to change these conditions in the Arctic (Dawson et al., 2011) and on Herschel Island (Cooley et al., 2012; Myers-Smith, Hik, et al., 2011; Wrona et al., 2016).

Sea ice, as one major factor influencing tourism exploration in the Canadian Arctic, is supposed to melt in up coming centuries (Stewart et al., 2009). Blankholm (2009) state that ice content diminishes around 2-3% each year. But no evidence of a positive relationship between climate change on sea ice extent and possibility of cruise ship tourism in the Arctic has been found (Stewart et al., 2009). Even with impacts from climate change the extent of sea ice stays unpredictable (Stewart and Draper, 2006) and routes for cruise ship tourists are uncalculable (Stewart et al., 2009). Anyhow, the accessibility for tourists is a crucial factor influencing the amount of visitors (Jha, 2005) and changing environmental conditions create opportunities for new shipping routes (Irrgang, 2017).

Apart from accessibility to historic sites, the sites themselves might be threatened by further climate change (Radosavljevic et al., 2016; Irrgang, 2017). As temperatures in the Arctic rise twice as fast as everywhere else (Irrgang, 2017), resulting impacts arose fast. The annual global sea level rise is predicted to range at 1.7mm/a (Radosavljevic et al., 2016),

but increases to 2.5mm/a for the Beaufort Sea region (Irrgang, 2017). The sea level rise will threat existing settlements and possible further infrastructure at historic sites on Herschel Island Qikiqtaruk (Irrgang, 2017). Irrgang (2017) estimated, that around 50% of all known historic sites in the Arctic might be vanished by 2100 through sea level rise. Without historic places to visit, the number of tourists would probably decline.

To effectively understand the connection between climate change and tourism, further research is necessary. It has been accepted to be important for tourism in polar regions (Stewart et al., 2009) and concerns are rising about the relation between environment and tourism (Stewart et al., 2005).

6.4. Management Recommendations for Herschel Island Qikiqtaruk Territorial Park

The main focus of Herschel Island Qikiqtaruk Territorial Park is the preservation of a wilderness and historic area with traditional use opportunities (Yukon Government, 2006; Yukon Government, 2018a). Negative impacts from different visitor groups to Herschel Island Qikiqtaruk Territorial Park have to be mitigated and avoided. The Territorial Park management plans of 2006 and 2018 are comprehensive and elaborate management guidelines for this purpose. They conclude a thorough analysis with existing capacity for conservation issues.

As Herschel Island Qikiqtaruk is located in the ISR, the administrative regulations of the IFA have to be applied (see subsection 3.3.1, p.23). Therefore the management plans are prepared by government and Inuvialuit representatives and are consistent with the IFA, the Parks and Lands Certainty Act, the Historic Resources Act and the Herschel Island Park Regulations (Yukon Government, 2006; Yukon Government, 2018a). In a final review

process the WMAC and the Yukon Parks Government will be counseled (Yukon Government, 2006; Yukon Government, 2018a). This review process results in a well developed, comprehensive including of all stakeholders of the Territorial Park.

But, with the possibility of further increase in number of visitors (see section 6.3, p.62) and under climate change the management suggestions might not reach far enough. Therefore, this chapter tries to supplement some scientifically evaluated conservation practices to the management plans for the mitigation of rising number of visitors.

6.4.1. Management Recommendations on the Level of Individual Visitors

As before hand discussed, visitors have distinct impacts on the Arctic environment, when visiting Herschel Island (see subsection 6.1.2, p.57). The biggest issues arose from trail development, which should therefore be mitigated. Two mitigation options, which are best applicable to Herschel Island, are the construction of board walks or dispersal of walking persons.

The construction of board walks comes along with some difficulties. On the one hand, they are known to alter vegetation underneath (Stewart et al., 2017) due to shade and providing wind shelter for sensitive plant species (Ballantyne and Pickering, 2015). On the other hand, they are suggested to restrict the spread of vegetation trampling (Stewart et al., 2017; Monz, Pickering, and Hadwen, 2013), reduce ecological changes (Monz et al., 2013), restrict erosion resulting from trampling (Stewart et al., 2017) and increase durability of resources (Leung, Spenceley, Hvenegaard, Buckley, and Groves, 2018). While trail development would impact the hydrological regime, impacts of board walks on permafrost are yet unknown. Except, that board walks should be implemented with wooden stilts, to avoid heat conduction. Further on, a steel mesh on top of the wooden stilts might be helpful to avoid shading (Ballantyne and Pickering, 2015). Additionally, material use

and maintenance might become complicated. As Herschel Island is a remote location, the transportation will be expensive. Also R. Gordon suggests that board walks would alter the wilderness and historic impression of the site, which is not desired from park management (see appendix A.4). If the amount of visitors, especially cruise ship visitors, would increase several times, board walks might become a more interesting conservation approach. With rising numbers, trails are supposed to develop and alter the wilderness characteristics of the area. Therefore board walks would at least mitigate the erosion impact and possibly avoid changes in vegetation.

The other mitigation option is to disperse the visitors on a wide area, to avoid trail development. As discussed before, the initial intensity of disturbance has the highest negative impact compared to the later use of a trail (see subsection 6.1.2, p.57), thus dispersal might not be a suitable option for some sites. But Monz et al. (2013) suggest, that this curvilinear relationship of disturbance and consequences is too simplified. Highly resistant and resilient substrates are supposed to sustain the prior minimal trampling (Monz et al., 2013). These areas can be found in the ecological class Thrasher and at the beach split of Herschel Island. Instead of installing board walks in this areas, a dispersal of visitors, as already practiced (see appendix A.4) is the most likely option. If dispersal is used as mitigation method, it should be accompanied by a holistic interpretation approach. Interpretation has been shown to significantly reduce visitor impacts (Littlefair and Buckley, 2008). Therefore visitors are informed about minimal impact codes and the visitor to guide ratio has to be low (Stewart et al., 2017).

As impacts can never be mitigated completely (Eagles, McCool, and Haynes, 2002; Leung et al., 2018) they should be kept spatially defined (Becker et al., 2016; Stewart et al., 2017). It is supposed to remove as little vegetation cover as possible (Becker et al., 2016) and avoid areas of ice-rich soils (Walker and Walker, 1991; Becker et al., 2016).

6.4.2. Management Recommendations for Cruise Ships and Their Visitors

Indeed, all management recommendations for individual visitors are applicable for cruise ship visitors, but particularly cruise ship visitors can be problematic, as they arrrive for a short time period trampel with high intensity (Eagles et al., 2002). Arctic expedition-style cruise ships add strain to the already stressed environment (Lemelin et al., 2010) and are recently somehow uncontrolled (Stewart and Draper, 2006).

Most often cruise ships carry large amounts of passengers, which can cause huge and quick impacts on the environment if they disembark (Eagles et al., 2002). Cruise ships anchoring close to Herschel Island are most often expedition-style cruise ship vessels. These vessels commonly carry less passengers (Eagles et al., 2002), but still many for Herschel Island (see chapter 5.1, p.40). Besides reaching Herschel Island Qikiqtaruk Territorial Park, a permit from the park management for anchoring and disembarking is necessary (Yukon Government, 2006; Yukon Government, 2018a). In general, permits contain the possibility to limit the access to places (Stewart et al., 2017; Littlefair and Buckley, 2008). To reduce the impact of cruise ship visitors one option is to withhold permits for access. As this does not accompany the intention of a welcoming Territorial Park, a limitation of access is not yet an option (personal communication R. Gordon). Another possibility to reduce the impact of cruise ship visitors is, as well, a holistic interpretation program (Littlefair and Buckley, 2008). It is already practiced and includes on ship orientation, a limit of the group size, promotion of a code of conduct and educational material (Gordon and Eckert, 2013; Historic Sites, Tourism and Culture of Yukon Government, 2013).

An additional problem of cruise ship management is the non existing international and national framework (Lasserre and Têtu, 2015; Stewart and Draper, 2006; Stewart et al., 2009; Landorf, 2009). It is highly recommended to establish a thorough management for monitoring and safety of cruise ships (Lasserre and Têtu, 2015). As many different governments rule parts of the Arctic, it is important to establish this management guideline

as international guideline (Hall and Saarinen, 2010). A first step is made by the Association of Arctic Expedition Cruise Operators (AECO). The association is a network of voluntary united cruise tour operators. They developed several guidelines for safety reasons and visitor guidance. But it has to kept in mind, that this association represents the industry-interests of cruise tourism operators, besides their environmental-friendly appearance (AECO, 2019)

Further more an integrated management would also be helpful in analyzing impacts of cruise tourism (Stewart and Draper, 2006). Until now, most governments and some communities set up individual restrictions (Stewart et al., 2005) and the overview is scarce (Lasserre and Têtu, 2015). On Herschel Island, where cruise ship landings are highly dependent on weather and sea-ice conditions, an overview of the overall traveling cruise ships could help for capacity planning (e.g. if the park rangers stay longer or leave earlier).

6.4.3. Management Recommendations for Protected Areas

As Territorial Park, Herschel Island Qikiqtaruk is established as typical protected area with a wilderness and a historic zone (see section 3.1, p.15). Each protected area has its own management specialities and history. Therefore recommendations on the meta-level have to be adapted to the distinct situation.

In general, a focus on tourism in protected areas is mostly managed under the question

> *"How much damage to the natural environment is worth the positive economic and quality life gains from park tourism?"* (Eagles et al., 2002, p. 79, para. 1)

To minimize damage to the natural environment, sustainability principles like holistic planning and decision making, the preservation of ecological processes, the protection of human heritage and biodiversity and a long-term sustainable growth in visitors (Landorf, 2009), should be aspired. Further it has to be considered, that the world is dynamic

and a static conservation plan might not be flexible enough to serve changing demands (Eagles et al., 2002). Nowadays the interest in low-impact tourism is on a steady rise. People search for national parks, World Heritage Sites and protected areas as desired places for sustainable and ecotourism (Eagles et al., 2002). Management plans therefore have to be adoptable to rising numbers of tourists.

Besides influences of tourism management in protected areas, monitoring of environmental conditions is one of the most important assignments (Leung et al., 2018). Still, the value of information sometimes may not outrun the costs of monitoring activities (Colyvan, 2016). They should be evaluated carefully, as good management decisions rely on sufficient information.

Also different stakeholders should participate in management development and implementation (Landorf, 2009), while local residents should not be negatively affected by conservation plans (Eagles et al., 2002). This is especially crucial for indigenous people (Leong, Takada, Hanaoka, and Yamaguchi, 2017). At Herschel Island Qikiqtaruk Territorial Park this recommendation is already fulfilled with the comprehensive teamwork for the management plan and the management of the park itself under the IRC (for further explanation see subsection 3.3.1, p.23).

Another threat to the existing management of Herschel Island Qikiqtaruk Territorial Park are changing environmental conditions. With further proceeding of climate change, infrastructure, settlements and historic sites are at risk (Irrgang, 2017). Ongoing coastal erosion has already forced the relocation of buildings (Radosavljevic et al., 2016). Holistic conservation approaches should implement global climate changes and threats into their management plans (Tyson, Lantz, and Ban, 2016; Jones, Watson, Possingham, and Klein, 2016).

7. Conclusion

The overall aim of this thesis was to examine the possible influence from designation as cultural and natural World Heritage Site for Herschel Island Qikiqtaruk Territorial Park. The different approaches to answer potentially occurring shifts resulted in a thorough analysis of the actual framework, vegetation alteration and permafrost impacts.

First of all the comparison of the management plans and the UNESCO guidelines did not indicate any complications at the administrative level. Therefore the natural and cultural World Heritage Status would not result in any formal changes in management approaches at the Territorial Park.

Admittedly a designation as a cultural and natural World Heritage Site of Herschel Island Qikiqtaruk has been determined to likely increase the amount of visitors. Due to Herschel Island's remoteness and global anonymity it would benefit from the additional branding as site worth visiting.

In consequence an increasing visitor use has been identified to result in higher anthropogenic disturbances, which will lead to further damage of vegetation and permafrost by trampling. Accordingly the touristic pressure on Herschel Island Qikiqtaruk Territorial Park can be expected to alter the tundra ecosystem and might impact biogeochemical permafrost processes.

Based on the conclusion further management strategies in case of higher number of visitors, like board walks and dispersal strategies, should be considered by the park management. They might become necessary to mitigate occurring damages before these become

severe. Despite of all, a sustainable tourism and a traditional use by Inuvialuit should be possible and consistent with reasoned development and extensive monitoring under the brand as a natural and cultural World Heritage Site.

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A. Appendix

A.1. Compilation of Existing and Unavailable Datasets for the Thesis

Available Datasets

- Monitoring reports of cruise ship visitation 2013
- Walking trail of cruise ship visitors
- Ecological class classification from Eischeid (2015)
- Number of visitors
  - from Herschel Island
  - from Yukon
  - from Northwest Territories
- extensive literature
  - on polar tourism
  - on Arctic vegetation

Unavailable Datasets

- Monitoring report for more years
- Monitoring report for different cruise ships
- Impact measures on permafrost and vegetation by trampling
  - via visual site assessment from photographs
  - via remote sensing from satellite images with matching scale
  - via long-term monitoring with short- and long-term impacts
- Visitation statistics from World Heritage Sites before and after designation
- Visitation statistics from comparable sites
- GPS and DGPS datasets from research activities of institutes except AWI
- Adaptation to remote sensing ecological class categorization regarding the aim of the thesis
- plant species resilience to trampling

A.2. Overview of the Key Goals of the Herschel Island Management Plans from 2006 and 2018 and the UNESCO Guideline for World Heritage Sites

Table A.1.: Overview of the key goals of the two Herschel Island management plans from 2006 and 2018 and the UNESCO guideline for World Heritage Sites

Topic	Management Plan 2006	Management Plan 2018	UNESCO guideline
Main purposes	Maintaining the ecological and historic integrity of Herschel Island, while allowing for traditional wildlife harvesting	Maintaining ecological integrity through the conservation of ecosystems, wildlife and biodiversity integrated with traditional use	Adequate long-term legislative, regulatory, institutional and/or traditional protection and management
			Organized protection on a permanent basis in accordance with modern scientific methods
	Conservation of wildlife and habitat	Conservation of wildlife, habitat and traditional native use as outlined in the IFA	To take the appropriate legal, scientific, technical, administrative and financial measures necessary for identification, protection, conservation, presentation and rehabilitation of heritage
	Protection of heritage resources and traditional use		
	Protect existing historical, cultural, archaeological and paleontological resources adjacent to Pauline Cove	The historic, archaeological and paleontological values are conserved and interpreted	
	Implement a long-term monitoring and protection program (strategic direction for the next 10 years)	Strategic direction for the next 10 years	Report on the status and actions on the world heritage properties (6 year cycle)

Continued on next page

Table A.1.: Sequel of the key goal overview

Topic	Management Plan 2006	Management Plan 2018	UNESCO guideline
	Provide the Inuvialuit with the opportunity to use the area in support of their traditional lifestyles	Inuvialuit feel welcome at the park and are able to contribute to visitor education and experiences by celebrating their culture and telling their stories	
	Enable Inuvialuit to be equal and meaningful participants in the northern and national economy and society	Park operations and visitation continue to provide direct and indirect economic opportunities to Inuvialuit Expanded participation of Inuvialuit citizens in field research and commercial tourism opportunities in the park	
Wildlife	Record wildlife sightings and support existing wildlife monitoring programs Protect and manage wildlife populations and habitats within the area		Natural heritage
	Make use of developed management plans to guide management of wildlife	Contribute and consider other management plans that pertain to wildlife and conservation research on the North Slope	
Heritage	Monitor conditions yearly, more intensive inspection every 5 years	Continue researching, monitoring and documenting historic and heritage resources to ensure their heritage values are maintained	Cultural heritage

Continued on next page

Table A.1.: Sequel of the key goal overview

Topic	Management Plan 2006	Management Plan 2018	UNESCO guideline
	Implement long-term monitoring and protection program	Manage and conserve the parks heritage resources according to "Standards and Guidelines for the Conservation of Historic Places in Canada" (maintenance, use and development of the individual built, archaeological resources and the site as whole)	
	Showcase the built heritage resources and use them as resources to educate and create awareness		
		Pursue designation of the historic settlement area as a Yukon historic site under the Historic Resources Act	
		Participate in preliminary studies to advance the application of Herschel Island as World Heritage Site together with Ivvavik National Park und Vuntut National Park.	
Research (human use)	To research and monitor components of the ecosystem to understand their relation:- coastal erosion- tide monitoring- vegetation communities- plant species- climatic factors- weather	Implement Inventory, Monitoring and Research Program	Enhance capacity building and research

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Table A.1.: Sequel of the key goal overview

Topic	Management Plan 2006	Management Plan 2018	UNESCO guideline
	Coordinate research with (inter-)national organizations		Reports of the world heritage have to be send to the secretariat, UNESCO and advisory bodies
	Utilize traditional and local knowledge and work closely with Inuvialuit (WMAC, Yukon Government, Ivvavik National Park stuff, ISR, HTC, etc.)	Strong cooperation for integrated management with Ivvavik National Park, WMAC North Slope Wildlife and Conservation Plan, Aklavik Inuvialuit Community Conservation Plan and various other plans	Increase participation of local and national population in the protection and presentation of heritage
	Researchers are required to obtain a park permit and a "Scientists and Explorer Permit" to conduct studies	Independent research requires "Yukon Park Permit" and a "Scientists and Explorer licence" (mechanism to protect park values, minimize potential impacts and evaluate contribution of research to park goals)	
	Access and support existing data for research	Facilitate opportunities for the Government and independent researchers to share and present their findings with park managers, Inuvialuit communities and the general public	
			Develop scientific and technical studies and research and work out operating methods

Continued on next page

Table A.1.: Sequel of the key goal overview

Topic	Management Plan 2006	Management Plan 2018	UNESCO guideline
Inuvialuit (human use)	Provide the opportunity to use the area in support of their traditional lifestyles	Inuvialuit feel welcome at the park and are able to contribute to visitor education and experiences by celebrating their culture and telling their stories	Activities of traditional societies and local communities often occur in natural areas, activities may be consistent with the outstanding universal value of the area, where they are ecologically suitable
		Herschel Island is a place for traditional use and cultural connection where Inuvialuit can convey oral history and knowledge to younger generations	
	Allowance to collect medicinal plants		Enhance function of world heritage in the life of the community
	Ensure that Inuvialuit have continued access to the land to pursue traditional harvesting activities (hunting porcupine caribou, char and cisco, using the icehouse)	See opportunities to collaborate with Inuvialuit organizations to facilitate on-site programming for Inuvialuit	
		Continue to employ Inuvialuit citizens in all aspects of park operations	

Continued on next page

Table A.1.: Sequel of the key goal overview

Topic	Management Plan 2006	Management Plan 2018	UNESCO guideline
		Create opportunities for sharing Herschel Island stories and build Inuvialuit connections to the park at regional events, gatherings, schools, etc.	
Visitors (human use)	Provide opportunities for people to learn and understand the natural and cultural values of Herschel Island	Park visitors feel welcome and leave with meaningful visitor experiences and a better understanding of Herschel Island	Raise general public awareness, understanding and appreciation of the need to preserve natural and cultural heritage
	Record numbers, types and activities of visitors	Continue cruise ship monitoring	Protect property from social, economic and other pressures and changes
	Prepare guidelines for visitor behavior	develop a set of best practices and protocols for all visitation to maintain quality visitor experience and public safety and to minimize detrimental impacts to the parks values	
	Ensure that visitors of the island understand the different types of use		
	Pursue a ratio of one ranger for 15 cruise ship visitors in one landing	(see cruise ship monitoring protocols)	
	To record, monitor and manage human use to reduce impacts in the park and regional ecosystem		

Continued on next page

Table A.1.: Sequel of the key goal overview

Topic	Management Plan 2006	Management Plan 2018	UNESCO guideline
		People who may not travel to Herschel Island have opportunities to understand and appreciate the park and Inuvialuit culture	

End of table

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A.3. List of plant species and associated ecological classes

Table A.2.: List of plant species on Herschel Island and the associated vegetation types and ecological classes

Species	Family	Vegetation type	Ecological class
Aconitum delphinifolum	Herb	Willow/Lupine-Lousewort	Thrasher
Alectoria ochroleuca	Lichen	Cottongrass/Moss, Willow/Dryas-Vetch	Herschel, Plover-Jaeger, Komakuk
Alopecurus alpinus	Grass	Sedge-Grass, Grass/Chamomile-Wormwood	Thrasher
Alopecurus spp.	Grass	Sedge-Grass	Orca
Arctagrostis latifolia	Grass	Grass/Chamomile-Wormwood	Thrasher
Arctostaphylos alpina	Dwarf-Shrub	Willow/Dryas-Vetch	Plover-Jaeger, Komakuk
Artemisia spp.	Herb	Willow/Lupine-Lousewort	Thrasher
Artemisia tilessii	Herb	Grass/Chamomile-Wormwood	Thrasher
Astragalus umbellatus	Herb	Willow/Dryas-Vetch, Willow/Saxifrage-Coltsfoot, Willow/Lupine-Lousewort	Plover-Jaeger, Komakuk, Thrasher, Wet Terrain
Astralagus alpinus	Herb	Willow/Dryas-Vetch	Plover-Jaeger, Komakuk
Bryophyte	Moss	Sedge-Grass	Orca
Carex auquatilis	Grass	Sedge-Grass	Orca
Carex rariflora	Grass	Sedge-Grass	Orca
Carex rupestris	Grass	Willow/Lupine-Lousewort	Thrasher
Carex spp.	Grass	Grass/Chamomile-Wormwood	Thrasher
Caryophyllaceae	Herb	Sedge-Grass	Orca
Cassiope tetragona	Dwarf-Shrub	Cottongrass/Moss	Herschel
Castilleja elegans	Herb	Willow/Lupine-Lousewort, Grass/Chamomile-Wormwood	Thrasher
Centrari nivalis	Lichen	Willow/Dryas-Vetch	Plover-Jaeger, Komakuk

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Table A.2.: Sequel of plant species on Herschel Island and the associated vegetation types and ecological classes

Species	**Family**	**Vegetation type**	**Ecological class**
Cetraria cucullata	Lichen	Cottongrass/Moss, Willow/Dryas-Vetch, Willow/Lupine-Lousewort	Herschel, Plover-Jaeger, Komakuk, Thrasher
Cetraria islandica	Lichen	Cottongrass/Moss	Herschel
Crucifera spp	Herb	Cottongrass/Moss, Sedge-Grass	Herschel, Orca
Dactylia arctica	Lichen	Cottongrass/Moss	Herschel
Dryas integrifolia	Dwarf-Shrub	Cottongrass/Moss, Willow/Dryas-Vetch, Willow/Saxifrage-Coltsfoot, Willow/Lupine-Lousewort	Herschel, Plover-Jaeger, Komakuk, Thrasher, Wet Terrain
Equisetum spp.	Equisetum	Sedge-Grass, Willow/Saxifrage-Coltsfoot, Shrub Zone, Wet Terrain	Plover-Jaeger, Shrub Zone, Wet Terrain, Orca
Eriophorum vaginatum	Grass	Cottongrass/Moss	Herschel
Eriophorum spp.	Grass	Sedge-Grass	Orca
Festuca spp.	Grass	Willow/Saxifrage-Coltsfoot	Plover-Jaeger
Gramineae spp.	Grass	Grass/Chamomile-Wormwood, Sedge-Grass	Thrasher, Orca
Lagotis spp.	Herb	Cottongrass/Moss, Willow/Saxifrage-Coltsfoot	Herschel, Plover-Jaeger
Ledum decumbens	Dwarf-Shrub	Cottongrass/Moss	Herschel
Ledum groenlandicum	Dwarf-Shrub	Cottongrass/Moss	Herschel
Lupinus arcticus	Herb	Willow/Dryas-Vetch, Willow/Lupine-Lousewort	Plover-Jaeger, Komakuk, Thrasher
Luzula nivalis	Rush	Willow/Lupine-Lousewort	Thrasher
Matricaria ambigua	Herb	Grass/Chamomile-Wormwood	Thrasher

Continued on next page

Table A.2.: Sequel of plant species on Herschel Island and the associated vegetation types and ecological classes

Species	**Family**	**Vegetation type**	**Ecological class**
Myosotis alpestris	Herb	Willow/Dryas-Vetch, Willow/Lupine-Lousewort, Grass/Chamomile-Wormwood	Plover-Jaeger, Komakuk, Thrasher
Oxytropis nigrescens	Herb	Willow/Dryas-Vetch, Willow/Saxifrage-Coltsfoot	Plover-Jaeger, Komakuk
Papaver spp.	Herb	Cottongrass/Moss	Herschel
Parrya nudicaulis	Herb	Willow/Dryas-Vetch	Plover-Jaeger, Komakuk
Pedicularis capitata	Herb	Cottongrass/Moss, Willow/Dryas-Vetch, Willow/Lupine-Lousewort	Herschel, Plover-Jaeger, Komakuk, Thrasher
Pedicularis spp.	Herb	Sedge-Grass	Orca
Pedicularis sudetica	Herb	Grass/Chamomile-Wormwood	Thrasher
Peltigera spp.	Lichen	Willow/Lupine-Lousewort	Thrasher
Petasites frigidus	Herb	Shrub Zone, Wet Terrain	Shrub Zone, Wet Terrain
Petasites spp.	Herb	Sedge-Grass, Willow/Saxifrage-Coltsfoot, Grass/Chamomile-Wormwood	Plover-Jaeger, Thrasher, Wet Terrain, Orca
Polemonium spp.	Herb	Sedge-Grass	Orca
Polygonum bistorta	Herb	Cottongrass/Moss	Herschel
Polygonum viviparum	Herb	Willow/Saxifrage-Coltsfoot	Plover-Jaeger, Wet Terrain
Puccinellia spp.	Grass	Grass/Chamomile-Wormwood	Thrasher
Puccinellia spp.	Grass	Willow/Lupine-Lousewort	Thrasher
Ranunculus spp.	Herb	Sedge-Grass	Orca
Ranunculus turneri	Herb	Willow/Lupine-Lousewort	Thrasher
Rumex spp.	Herb	Sedge-Grass	Orca

Continued on next page

Table A.2.: Sequel of plant species on Herschel Island and the associated vegetation types and ecological classes

Species	Family	Vegetation type	Ecological class
Salix arctica	Shrub	Cottongrass/Moss, Willow/Dryas-Vetch, Willow/Saxifrage-Coltsfoot, Willow/Lupine-Lousewort, Grass/Chamomile-Wormwood, Shrub Zone, Sedge-Grass	Herschel, Plover-Jaeger, Komakuk, Shrub Zone, Thrasher, Wet Terrain, Orca
Salix pulchra	Shrub	Cottongrass/Moss	Herschel
Salix reticulata	Shrub	Cottongrass/Moss, Willow/Dryas-Vetch, Willow/Saxifrage-Coltsfoot, Willow/Lupine-Lousewor, Shrub Zone	Herschel, Plover-Jaeger, Komakuk, Shrub Zone, Thrasher, Wet Terrain
Salix richardsonii	Shrub	Shrub Zone	Shrub Zone
Salix spp.	Shrub	Sedge-Grass	Orca
Sausserea angustifolia	Herb	Cottongrass/Moss	Herschel
Saxifraga cernua	Herb	Sedge-Grass	Orca
Saxifraga hieracifolia	Herb	Willow/Lupine-Lousewort	Thrasher
Saxifraga hirculus	Herb	Sedge-Grass, Willow/Saxifrage-Coltsfoot	Plover-Jaeger, Wet Terrain, Orca
Saxifraga punctata	Herb	Cottongrass/Moss	Herschel
Senecio congestus	Herb	Grass/Chamomile-Wormwood	Thrasher
Senecio lindstroemii	Herb	Cottongrass/Moss, Willow/Dryas-Vetch	Herschel, Plover-Jaeger, Komakuk
Senecio spp.	Herb	Willow/Saxifrage-Coltsfoot	Plover-Jaeger, Wet Terrain
Stellaria monantha	Herb	Cottongrass/Moss	Herschel
Thamnolia subuliformis	Lichen	Cottongrass/Moss, Willow/Dryas-Vetch, Willow/Lupine-Lousewort	Herschel, Plover-Jaeger, Komakuk, Thrasher
Trisetum spicatum	Grass	Grass/Chamomile-Wormwood	Thrasher
Vaccinium uliginosum	Shrub	Cottongrass/Moss	Herschel
Vaccinium vitis-idaea	Shrub	Cottongrass/Moss	Herschel

Continued on next page

Table A.2.: Sequel of plant species on Herschel Island and the associated vegetation types and ecological classes

Species	**Family**	**Vegetation type**	**Ecological class**
Valeriana capitata	Herb	Cottongrass/Moss, Sedge-Grass, Willow/Lupine-Lousewort	Herschel, Thrasher, Orca

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A.4. Interview with Senior Park Ranger Richard Gordon

The following section contains the transcribed version of a Skype interview with Richard Gordon. Richard Gordon works at the Herschel Island Territorial Park as Senior Park Ranger and is Inuvialuk. He has grown up in close relationship to Herschel Island and is a specialist of the practical daily workload on the island.

Day of record	27.08.2018
Place of record	Skype call
Duration of record	28 minutes 55 seconds
Name of recording person	Kira Heinemann
Name of transcribing person	Kira Heinemann
Speakers	RG = Richard Gordon, HL = Hugues Lantuit, KH = Kira Heinemann
[...]	indicates missing transcription, due to bad audio quality

HL Ah perfect, we got the two of you, so thanks a lot, that's great we managed, so thanks Richard for making Time
RG Ja
HL next time I think will be drinking a beer in Venice
RG Oh my goodness
HL jap, that sounds good, I prepared everything, I got your room, I asked them to repaint it in some green and gold and stuff and then George is gonna be your personal servant, the entire time.
RG Hes gonna be what?
HL Hes gonna be your personal servant
RG Oh, oh okay

HL that's gonna be nice, so Kira started and she has a couple of questions, a couple of them got answered by Sam already, so that's fantastic about the trails. But basically what she is looking at, I told you, is trying to understand what could more or less tourism change for the island and she had a couple of questions, because she's never been to the island to understand and how, what you would be able to say about that. - Would, Kira do you wanna get started?

KH We could, If you're ready?

RG Jep, I'm sorting you some pictures, too

KH Oh okay, what pictures are you looking at?

RG Ahh, I don't know you've got them, just trail inventory, I took pictures of going up from the beach towards the ice houses, and from the ice houses to the RCMP graves

KH aha

RG I'm just trying to give you a visual, what these are all these remember said, I tried to find some before and after, but I had a really hard to time to go through that inventory, cause the pictures aren't labeled, its just pictures and I had to go through all of them cause they only got numbers an, so we've to go through all of them to find some

KH ah okay

RG Just trying to give you a real insight what the pictures are.

KH Okay

HL Okay, that's great. I mean, if you could, if you had the pictures I think it would be great for Kira to have look at them.

KH He already send me an Email it just came. Thank you.

HL faster than the wind

KH yeah

RG Yeah, I apologize for my slow response, [...] I've been busy about the stuff in work stuff and personal stuff and I didn't spend quality time on some of the questions and on the inventory you requested. So I'm just trying to have my hands on it right now.

KH thank you so much, that is so nice of you, I know you've a lot of work to do and I'm super glad you're doing it. I just can't think of looking through so many pictures. And they look awesome, I like them!

RG And then I think I'm going down next week, we've a cruise ship on September 6th and 13th. I can get some before and after pictures, like you have, I try get a before the cruise ship visit and after the first visit and a week later after that cruise ship visit so you have a kind of a impact on both a week apart.

KH wow! that would be super amazing, if that is not too much work for you?

RG Well no, at least I got an idea, I mean gives me an idea after this discussion, like this is to what you're looking for and I could find what you're looking for.

KH Okay

HL Okay, so well, that sounds great, I think you can fire up, Kira

KH Okay, so my first questions are regarding UNESCO. I would like to know, if you think **becoming a World Heritage site would have any effects on the island?** So do you think there might happen anything or does that change anything for you?

RG could you repeat that question thank you?

KH If you think that becoming a World Heritage site would have any effect on the island or the territorial park itself?

HL I think it's because, what we are trying to understand is and since the Island is on the candidate list to become a UNESCO site, if having the UNESCO status would change anything for the island, meaning more visitors or if it be I don't know.

RG I think they talked about that and **discussed that on the WMAC meetings along with Yukon Parks**. And the Question is what the status is and whats gonna change. I don't think if it, you know the, the status will change anything the way that we manage the environment from impacts from visitors or development in [...] the future, so I think the far we follow the goals of the management plan and keep, **keeping the park in its pristine natural state, to the greatest extent, that will be still the number one priority**.

KH aha

RG I know **with the cruise ship visitation and the say privat yard area all sail boat going to more of the tourism business coming locally with the boat visits and the flying** and we are again visiting those areas and **how we gonna manage those in the future** and I think will have a discussion with Georgia the day i think **our work here is gonna be very important**, at least we've documented in a scientific form which we can use as part of the management regime in ensuring that we concept numbers, to manage the environmental impacts.

KH aha, would you like me, to give some **suggestions on how to manage the impact of huge numbers of tourists** in my thesis or do you think that would be to far?

RG I think **suggestions and stuff like that, because its coming from the scientific community would help**, you know again, we have to kind of a interpretive back to the community of Aklavik to see, there is we seen high impacts happening and we do our own inventory but coming from the scientific community would ensure that everyone is aware, it is not just from our eyeshade coming [...] nine people, and I think not in the past, the inventory of visitors and anyone on the island has been from **July to September, I think we had at least 900 visitors in one season, but the impact to the vegetation was very slightly visible, because visitors were spread out over certain place of time. But with the cruise ships, 170-200 visitors in a three hour window, does leave a negative impact on the vegetation in this day operation, so it is a concern that i have as a park manager and its a concern that the rangers rised and passed me of the footprint left behind by this big groups of people visiting, so that's and then with the help and we brought that in in one discussion, the imprint on along the whalers graves and that was in 2012 I think in that area that ah we shut down the area in 2015 we shut down the cruise ship visitors walking along the graves, cause they left a deep trench in the vegetation that was visible for a while**.

KH I have read about that, so do you think that **wooden paths, like bridges would help out for these places?**

RG You got to repeat, you we're breaking up after the last

KH Do you think that wooden paths would help for not building a trench or something like that in sensitive areas?

HL Yeah, what we were thinking, ah Richard, is ah I mean I've seen that in other places in the Arctic, that they put like planks, you know like wooden planks on piles, that people avoid walking on the ground, but I don't know what your feeling is about this.

RG We talked about that, you to you know **to put the boardwalks down, but that again would change the natural environment in the park, but you know and we did wanna check that** like you say it states in the management plan the national park staple that we just prevent the national park so that we [...] that keeping it the natural state as much as possible, and we kind a look at that, say yes we have to bind by that, **but with this global warming and the danger of the vegetation impacted, yes we have to revisit that issue, yes we will have to make a management decision based on, you know, the damage of the vegetation would it be more important to put boardwalks on**, but again, boardwalks [...] the high water that we are seeing more and more each year those are just, not **storm surges will wash the boardwalks away** just doing more, you're doing more work putting them back in place and trying stabilize them and so, those issues are there and again I guess it it may be on the management decision they have done how much vegetation damage is happening and along, they turn that **why we try to use the beach along to get to the hill side this to be a decision that has to be made based on the damage in the tundra area.**

KH And you said before there were more tourists but they came on different time. If you are free in things that you could wish, would you change the kind of visitors that are coming? So not so many cruise ships but instead more individual tourists on different days?

RG We have to take everything into consideration like in Yukon parks you know our, our welcome to **any visitors of the park is an open door**, we don't want to say no to anyone and under the management plan along the concerns from the Inuvialuit from overcrowded on concerns to vegetation or disturbance of wildlife in the area those are to be taken into consideration making that decision, so it's you know not I think this whole new visitation coming now is changed from the flying and now we got cruise ships and we are all worried managing two cruise ships per season on Herschel and we strike [...] with along with yacht visitors or private visitors because of the nearly cut highway [...] our strategy on how we gonna accommodate certain number of people during anyone operation season.

KH Mhm

RG So that be based on, you know domino road, we see the impact happening on one of the month, or on August as the wettest month would and we do that and start on making suggestions as to and how many ships vs yachts vs flying we gonna have on a the week [...] the two number is that one we can hold on Herschel. So its done that has to be measured and I think, making that kind of decision is, is because Herschel island is an island by itself and we have [...] landing areas, starting areas, you know **decisions have to be made on how much the impacts is on one day and season**

KH Mhm

HL So you two continue, I just need to move baby to his mother, because he is not happy with me

KH Okay, and if you say, **you see some impacts from visitors, do you see impacts from the researchers as well?**

RG Well, that again it is **something were we have to take inventory as well. And I don't think its really much to comply when the researchers are on the work because they're more smaller group and they're more spread out not walking on one main trail** and stuff like that for **when we have a cruise ship visit we have a 170-200, walking behind me on one given trail either on single path**, or when they spread out, you still have a lot of people in one area in a designated terrain, so you know. All that again have to be measured and how we the rangers do really look at it, and [...] there is an impact we have on one single line walking behind me and less impact if you have them more spread out. But again here we're stating areas, by walk the a – say that, you guys walk along the beach and then I'll meet you at the ice houses, then we came in the ten meters wide or whatever you have a few people, I mean **more people on one area it is an impact**. Its something that, you know its new, because of the cruise ship visits, its givingly new because of the tuck and the crawly that made increase in small businesses gives to these private yachts or to visitors coming by boat to Herschel. **One step, those guys will start making an inventory to what is the highest impact cruise ships, is it the Yachts with 60 people, with 30 people or is it the local tourism business that's coming in more often, all those things have to be measured**, so its a lot of unanswered questions those can be looked at in the future.

KH Okay and from the impacts, have you seen any special plants that are maybe shown by Cameron to you or that you just know, that are endangered or more sensitive to the tourists than other plants?

RG Say that again, I just got a little break up here

KH Do you know any plants that are endangered or especially sensitive to the visitors? That you know?

RG What? The plants?

KH yeah, some special plant, just one species that you know

RG Its a hard question to answer, once you strive and walking down, **towards the mission house there is certain plants that are rare**, that there is the visitors when they go to the mountain, that they not go into the mountain or on top of the mountain, that there is a good vegetation for flowers to grow in and once you walk across along the beach line **back to the tussock, the tundra area, how those plants are impacted is not really inventory managed at this time**, and that a think you know down in the future we see the increase of visitors coming into Herschel. Right now we're averaging, you know with the cruise ships, we **averaging 400 to 500 visitors per season**, in counting everybody. Do you take the cruise ship numbers and say with an 170-200 at the sons of a day, there was some impact to the flowers. **But again, because the cruise ships are late in the season and the flowers have already twisted and get ready to winter it is really hard to say what impacts are having**, you know vs the month of July. When there is more color and more [...] at that time

KH Okay, that is something I didn't knew. Interesting.

RG So ja, so I don't know like if its a negative or a positive, once you know they twisted in this time the season winterize is that walking or trampling or that spread the season or more so I don't know [...] about you probably have to [...]

KH Okay, maybe one last question: **have you heard that the visitors in the area, not only Herschel but in general, have risen, or that they are more?**

RG I think, you know, visitors in general for more or less, I think this year, they are not, concluding Herschel itself, cause I think **we are still averaging the same number each and every year**, I think we've seen an **increase in the Nirituk highway in people driving towards there**. This is the first year that the Nirituk Highway have been open. [...] on a window to more visitors in adventure in the future. I don't know if they did start any inventory on you know all these people walking in the tundra along the Tuktanirik Highway. **I know there's an increase in Inuvialuit use for a, for a the crowd berry harvest this year, all people using the Tuk Highway,** cause its a new one a along part of a berry along that highway.

KH I think you've answered most of my questions so far. And you guys know a lot of answers I have to still think about. I didn't know a lot of this. That was really interesting and before I forget it and I have to say greetings from Anna to you

RG Oh Anna, yeah?

KH ja, she said, I should tell you that.

HL Richard, there is an really important question that Kira wanted to ask, but she wasn't shure if she could ask. She wanted to ask: Who is that amazing french researcher that is always coming to the island each year?

RG Ähm, an amazing french man ... ähm I don't know, he's got a hundred priorities.

HL He gave up on the island. No, I'm back next year, well you gonna meet my girlfriend, cause she's gonna be in there Venice. So you to guys can negotiate how I come to the island next year.

RG Oh ja, for shure, ja .Well I haven't been out to the island as much in the season this year, now it's a changing, changing things in management so if its, I think revisiting this whole thing, **I think the management plan, too is on its final stages** and things like that too, so again. These kind of a stop, will manage in the book, but we're also in, again trying to involve Aklavik in the management of the park is getting less and less, people in Aklavik, cause **there's not much people traveling in this new generation so that too may have some kind of a visiting be more of a government structure park**, you know how much the Inuvialuit are gonna do, they are not there to address some of the inventory, that I've been told to. As lot as issues like that [...] Again working with Aklavik in this ensuring that they have a [...] in the management plan, they understand the roles and responsibility the Inuvialuit under the final agreement is gonna be a very important years of operation [...]

HL sounds great, Richard, thank for all of these, is there anything you need for Venice? Are you okay with the transportation and everything?

RG Ja so far I'm okay with that, I mean, I can't really get lost?

HL exactly, I think pretty much coming in on the same day and time as us, like many of us, like George is coming, Anna is coming, there are many people that would be coming, so we coming, I need to look at the ticket again

RG well sounds good and thanks for calling, I hope Kira you got all your information, and like I said, I'll try and get some more pictures for this season, so you got them more, you know, an inventory on dates and stuff like, to work even better.

KH Thank you very much, that would be nice.

RG Yeah, just, you can maybe send me a basically what you really looking for as pictures, I know you do the before and after, no much pictures I got on file here, is got foggy, I like to take more and more pictures of that, because the [...] trying to get the beach and the flat and the footprints and pictures and stuff like that.

KH Mhm, okay, I can do that, thank you

HL Okay great, fantastic, thanks a lot Richard and I see you in about a month from now.

RG Yeap, sounds good

HL Okay have a good one.

RG by

KH by by

A.5. Summary in German - Zusammenfassung

Der Bedarf an touristisch erschlossenen, naturnahen Ausflugszielen wird immer größer und damit auch die Notwendigkeit die Auswirkungen eines solchen Tourismus' zu untersuchen. Besonders schon bestehende Schutzmaßnahmen sollten unter touristischen Gesichtspunkten neu evaluiert werden. Deshalb beschäftigt sich diese Masterarbeit mit dem kanadischen Territorial Park Herschel Island Qikiqtaruk, der seit 2004 gemeinsam mit den angrenzenden National Parks Vuntuut und Ivvavik auf der Bewerbungsliste als Weltnatur- und kulturerbestätte steht. In der Masterarbeit wurden die möglichen Änderungen der Besuchszahlen und ihre Auswirkungen auf die Vegetation durch den Natur- und Kulturerbestatus untersucht, sowie mögliche Konsequenzen für das Parkmanagement.

Eine umfangreiche Literaturrecherche hat ergeben, dass die Besuchszahlen wahrscheinlich ansteigen werden, nachdem der Territorial Park als Weltnatur- und kulturerbestätte anerkannt wurde. Die Auszeichnung führt vor allem bei unbekannten, abgeschiedenen Weltnatur- und kulturerbestätten zu einer höheren Bekanntheit, die dann in einem Anstieg der Besuchszahlen resultiert.

Um die Auswirkungen des Tourismus einschätzen zu können wurden unterschiedliche Besuchsgruppen auf Herschel Island betrachtet. Dabei lag das Hauptaugenmerk auf Kreuzfahrtschifftourist*innen und Wissenschaftler*innen, die zum einen den größten Teil der Tagesgäste und zum anderen den größten Teil der Übernachtungsgäste ausmachen. Der Einflussbereich von Kreuzfahrtschifftourist*innen auf der Insel ist begrenzt auf einen Rundweg, der von Park Rangern begleitet wird und die meisten Sehenswürdigkeiten umfasst. Die Wissenschaftler*innen bewegen sich freier auf der Insel und ihr Einflussbereich wurde mit Hilfe der GPS und DGPS Daten von 2014-2017 ausgewertet.

Grundsätzlich konnte festgestellt werden, dass die anthropogenen Trampelschäden direkt mit der Intensität des Trampelns und den vorhandenen Umweltbedingungen zusammenhängen. Es konnten zwei ökologische Klassen identifiziert werden, die von Kreuz-

fahrtschifftourist*innen übernutzt werden. Durch ihre Übernutzung werden sich dort wahrscheinlich Trampfelpfade entwickeln, die zu einer weiteren Vegetationsveränderung und Bodenerosion beitragen können. Die Auswirkungen von Wissenschaftler*innen sind schlecht regional eingrenzbar. Je nach Forschung variieren die beeinflussten ökologischen Klassen. Allerdings hat sich gezeigt, dass auch das verteilte, wenig intensive Trampeln zu Vegetationsveränderungen führen kann.

Eine weitere Literaturrecherche hat gezeigt, dass die Vegetationsveränderungen und das Trampeln einen direkten, teilweise starken Einfluss auf den Permafrostboden haben. Da die arktische Ökologie in besonderem Maße von hydrologischen Prozessen beeinflusst wird, kann eine Veränderung dieser größere Folgen nach sich ziehen. Unter anderem erhöht sich die Schüttdichte, kurzzeitig die Feuchtigkeit und die Verfügbarkeit von Mineralstoffen im Boden aufgrund von Trampelschäden. Das wiederum beeinflusst die Vegetation.

Insgesamt lässt sich somit feststellen, dass die vorhandenen Schutzmaßnahmen der Vegetation und des Permafrosts auf Herschel Island mit veränderlichen Besuchszahlen erneuert werden müssen. Mögliche Auswirkungen, wie Vegetationsschäden, lassen sich durch ein umfangreiches Management kontrollieren oder sogar verhindern. Deshalb ist es sinnvoll als zukünftige Weltnatur- und kulturerbestätte vorausschauende Managementempfehlungen und Handlungsweisen parat zu haben um mit den Auswirkungen eines stärkeren Nutzungsdruckes umzugehen. Zwei passende Möglichkeiten für Herschel Island Qikiqtaruk bieten die Installation von Holzstegen oder das Ausweichen auf weniger sensitive ökologische Klassen.

Zudem hat sich gezeigt, dass die erwartbaren Regulierungen durch den Weltnatur- und kulturerbestatus nicht zu Vorschriftsänderungen in der grundsätzlichen Parkverwaltung führen. Mit einem Management, das auf veränderliche Besuchszahlen ausgelegt ist, sollte sich die ursprüngliche und wilde Natur von Herschel Island für die nächsten Jahre erhalten lassen.

Eidesstattliche Erklärung

Hiermit versichere ich an Eides statt, dass ich die vorliegende Arbeit selbstständig und nur mit den angegebenen Quellen und Hilfsmitteln (z. B. Nachschlagewerke oder Internet) angefertigt habe. Alle Stellen der Arbeit, die ich aus diesen Quellen und Hilfsmitteln dem Wortlaut oder dem Sinne nach entnommen habe, sind kenntlich gemacht und im Literaturverzeichnis aufgeführt. Weiterhin versichere ich, dass weder ich noch andere diese Arbeit weder in der vorliegenden Form als Leistungsnachweise in einer anderen Veranstaltung bereits verwendet haben oder noch verwenden werden. Die Arbeit wurde noch nicht veröffentlicht oder einer anderen Prüfungsbehörde vorgelegt.

Die „Richtlinie zur Sicherung guter wissenschaftlicher Praxis für Studierende an der Universität Potsdam (Plagiatsrichtlinie) - Vom 20. Oktober 2010“ ist mir bekannt.

Es handelt sich bei dieser Arbeit um meinen ersten Versuch.

Potsdam, den

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