

Memorandum – Coastal Engineering Review Pictured Rocks National Lakeshore (PIRO) – Miners Beach Stairs TAR 26824

10 April 2023

REVIEW REQUEST SUMMARY

A set of timber stairs that has been historically used to access the beach at Miners Beach was damaged in an October 2022 storm event, rendering them unusable. Damage to the stairs in this same location has occurred from storm events approximately every three years for about 15 years. The park would like a review of the site to identify what conditions and environmental factors may be contributing to the stairs' failure. In addition, the park would like a review of possible alternatives completed to determine what solutions may be available to maintain continual access to the beach in a safe and effective manner at either the present location or near the same location.

BACKGROUND

PIRO is located along the south shore of Lake Superior in the upper peninsula of Michigan.

Miners Beach is located to the east of Miners Castle (figure 1) and is popular for park visitors. Miners Beach stairs are connected to North Country Trail at the top of the stairs and serve as the main staircase and access point to Miners Beach (figure 2). The stairs were recently damaged on October 18, 2022 in a storm and are currently not usable (NPS 2022) (figure 3). There has been a history of the stairs being damaged. A review of historic aerial images and photographs show that the stairs have been replaced at least once since 2017.

Figure 2 shows the original layout of the stairs. These stairs were made of timber, were approximately 15 feet high, 12 feet wide, 45 feet long and contained about 25 steps (Google Earth Pro 2016). Figure 3 shows the stairs after they were damaged in the October 2022 storm. These stairs are made of timber. Before these stairs were damaged, they were approximately 18 feet high and contained about 18 steps from the top of the bluff to a landing, then 12 steps down to the beach (Google Earth Pro 2021).

Figure 1. Site Overview

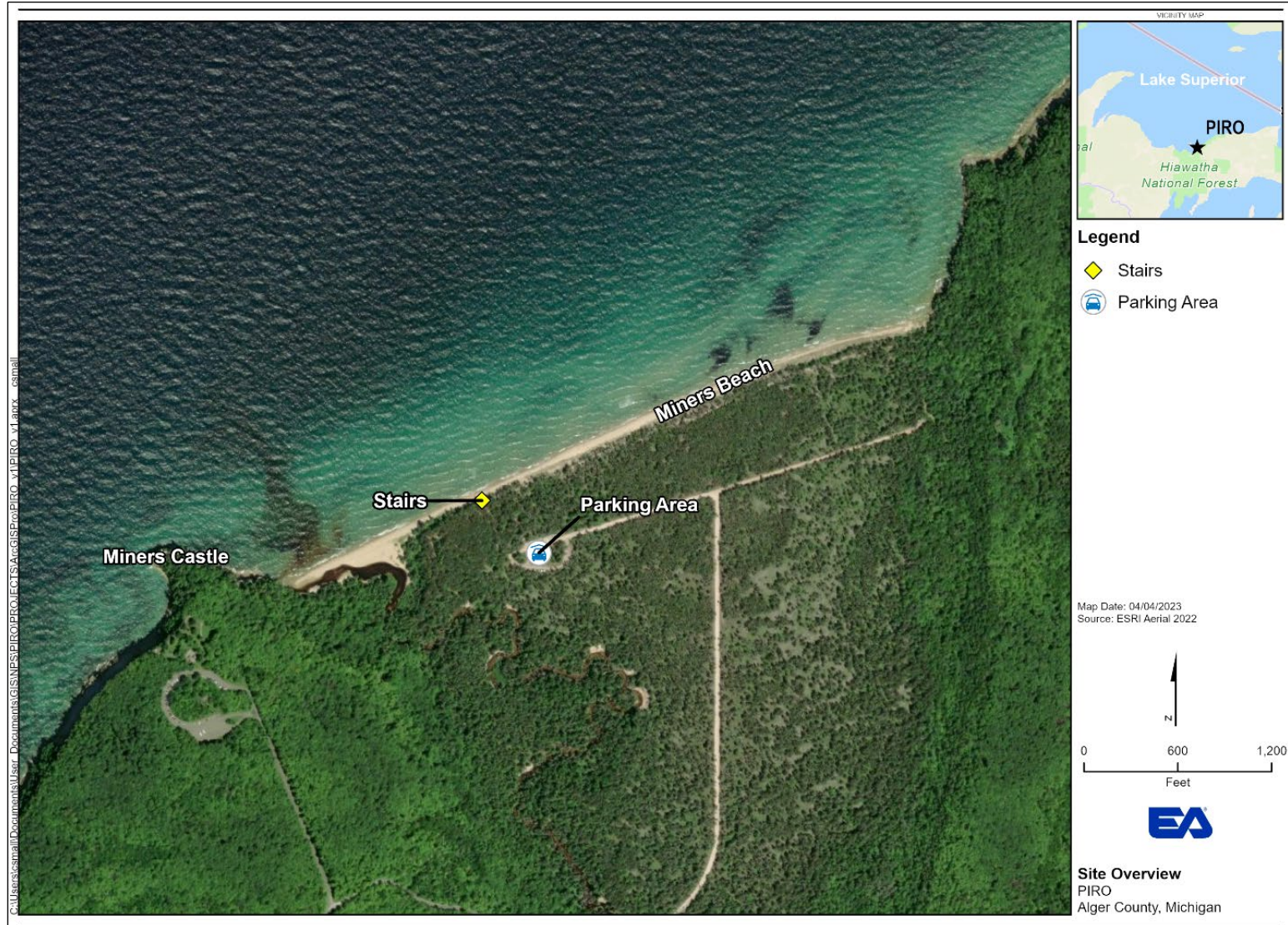
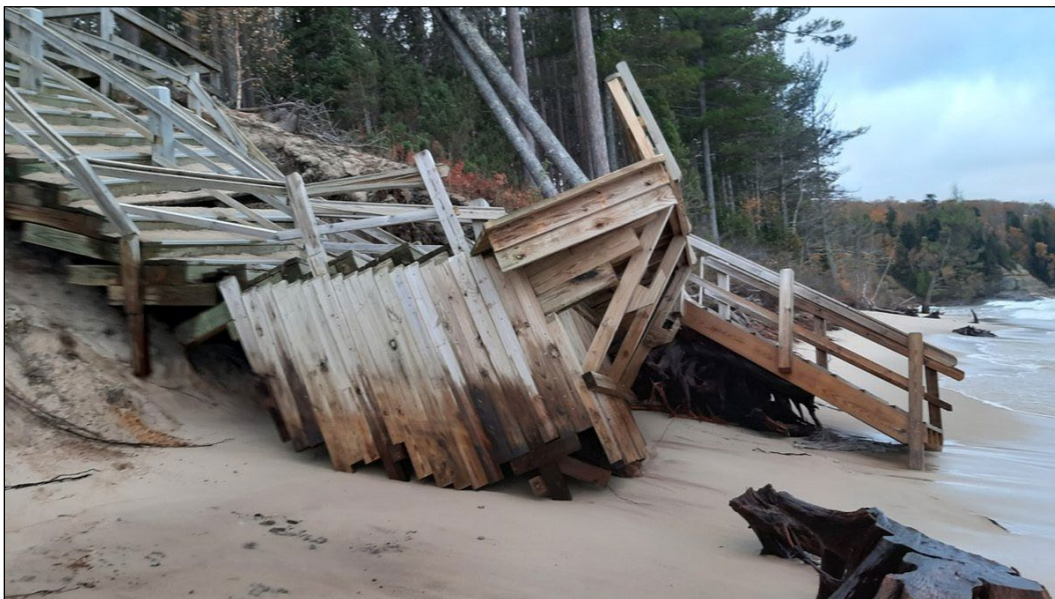


Figure 2. Miners Beach Stairs (Exploration America 2017)



Figure 3. Miners Beach Stairs Damaged in October 2022 Storm (TV6 News Team 2022)



EVALUATION

Data including site geology, elevation, aerial imagery, climate, wind, wave, water level, storms, and ice information were collected. A review of this information was performed to determine what may be causing the stairs to fail and what may be done to maintain access to the beach in a safe and effective manner. Specifically, the following was investigated:

- Geologic setting.
- Elevation data, historic aerials, and photographs to establish how the shoreline has changed over time and assess the stairs' vulnerability.
- How often water levels and waves reach a height close to/above the base of the stair area.
- The wind/wave directionality to understand how often waves are focused on this shoreline.
- The typical timing of ice formation/break up.

Geologic Setting

Miners Beach stretches for a mile along Lake Superior and consists of a sandy beach backed by a mostly vegetated sandy bluff approximately 15 feet tall. To either side of Miners Beach are sandstone cliffs that rise and occasionally expose bedrock (NPS 2022). The USDA National Resources Conservation Service soil type for Miners Beach area is 11C – Deer Park sand (Superior Watershed Partnership 2009). The slope at the beach fronting the stairs is 5.1 to 20% and increases to 35.1 to 75% for the bluff (Superior Watershed Partnership 2009). It should be noted that beach slope will vary depending on lake levels and wave factors.

Figure 4. Shoreline view (EGLE 2023 – Image #SS-0293, Year – 2012)



Elevation and Aerials

Miners Beach is a sandy beach that is shaped by environmental factors including wind, waves, changing water levels, storms, ice, and human factors including foot traffic and nearby development. A review of historic aerials and photographs appear to show loss of beach elevation in front of the stairs. Recent photographs and elevation data show the stairs to be about 18 feet high and about 18 steps from the top of the bluff to a landing, then 12 steps down to the beach, for a total of 30 steps (Google Earth Pro 2021). Photographs of earlier installations of the stairs (circa 2016) showed them to contain only about 25 steps and to be about 15 feet high (Google Earth Pro 2016a). Since the top of the bluff appears to be relatively unchanged, it is anticipated that additional stairs were necessary as the beach in front of the stairs has been subject to erosion resulting in a steepening slope.

Beaches can act as a buffer between the wave action of Lake Superior and the upland. Wide beaches with gentle slopes allow waves to break and dissipate energy before they impact upland structures (Virginia Institute of Marine Science 2010). If the beach is eroding, the stairs may be subject to increasing forces generated from the waters, winds, and waves. The following elevation data were reviewed to assess if the shoreline at the site is changing, and if this change is adversely impacting the stairs:

- 2019 USACE NCMP Topobathy Lidar DEM: Lake Superior (MI, MN, WI)
- 2011 USACE NCMP Topobathy Lidar DEM: Lake Superior (MI), Lake Ontario and Lake Erie (NY)

The 2019 elevation data is shown in figure 5. Four transects were cut to further characterize the site (figure 5). Transect 1 shows the profile at the existing stairs. In 2019, the top of the bluff near the stairs was approximately El. 625 feet (IGLD85), and the toe of the stairs was approximately El. 607 feet (IGLD85). The figure also shows that the elevation of the bluff ranges from EL. 622 feet in the vicinity of Transect 4 to El. 635 feet (IGLD85) in the vicinity of transect 2.

A comparison of the 2011 elevation data and 2019 elevation data is displayed in figure 6. The areas in red are areas where the erosion is occurring and the areas in blue are areas of accretion. Gray areas are areas of minimal change. Between 2011 and 2019 there was erosion of the beach in front of the stairs (figure 6). The beach erosion between 2011 and 2019 may have been due to a singular or multiple storm events or it may have been due to high lake levels. Between 2015 and 2020, lake levels were at historic highs. This may have contributed to the erosion of the beach between 2011 and 2019. Since 2020, lake levels have been receding, which may influence the beach and nearshore sediment dynamics. Lake water levels are discussed in further detail in the following section. Additional monitoring of the beach would be needed to determine if the beach is stable, eroding, or accreting as water levels in the lake fluctuate. A review of recent and historic photographs was inconclusive.

Figure 6 also shows the position of the shoreline in 2011 compared to the position of the shoreline in 2019. The average water level in 2011 was El. 600.75 feet (IGLD85). The 2011 contour representing El. 600.75 feet is shown in black. The average water level in 2019 was El. 602.95 feet (IGLD85). The 2019 contour representing 602.95 feet (IGLD85) is shown in purple. Between the erosion of the beach and the increase in water level, the position of the shoreline changed dramatically between 2011 and 2019. Water levels have decreased since they peaked in 2019/2020 (discussed further below), but the erosion of the beach has led to a reduction in beach width over the past decade leaving the site more vulnerable to wave action.

Figure 5. 2019 USACE NCMP Topobathy LiDAR DEM at PIRO (USACE 2019)

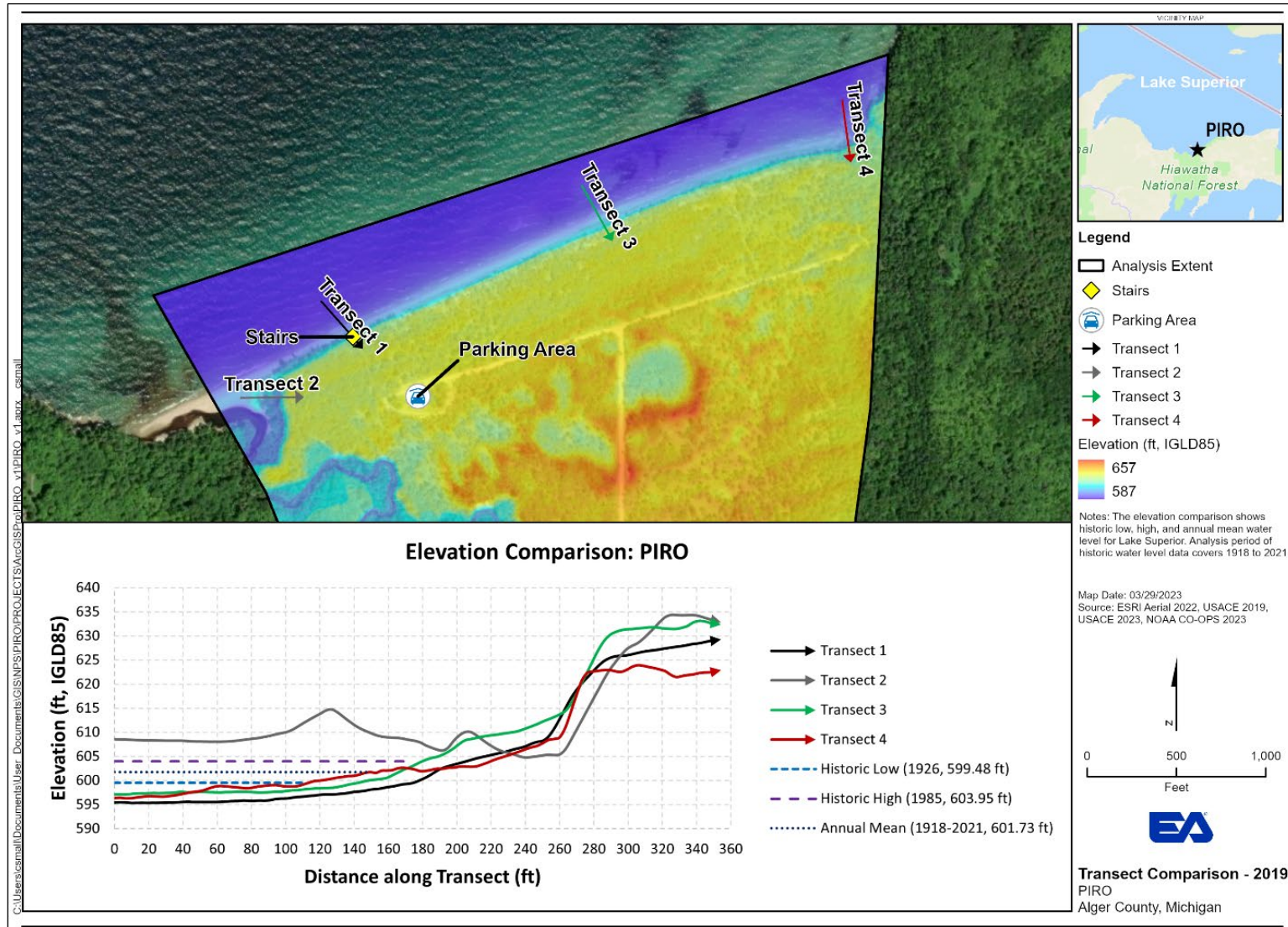


Figure 6. Shoreline change (2011 – 2019) (USACE 2011 & 2019)

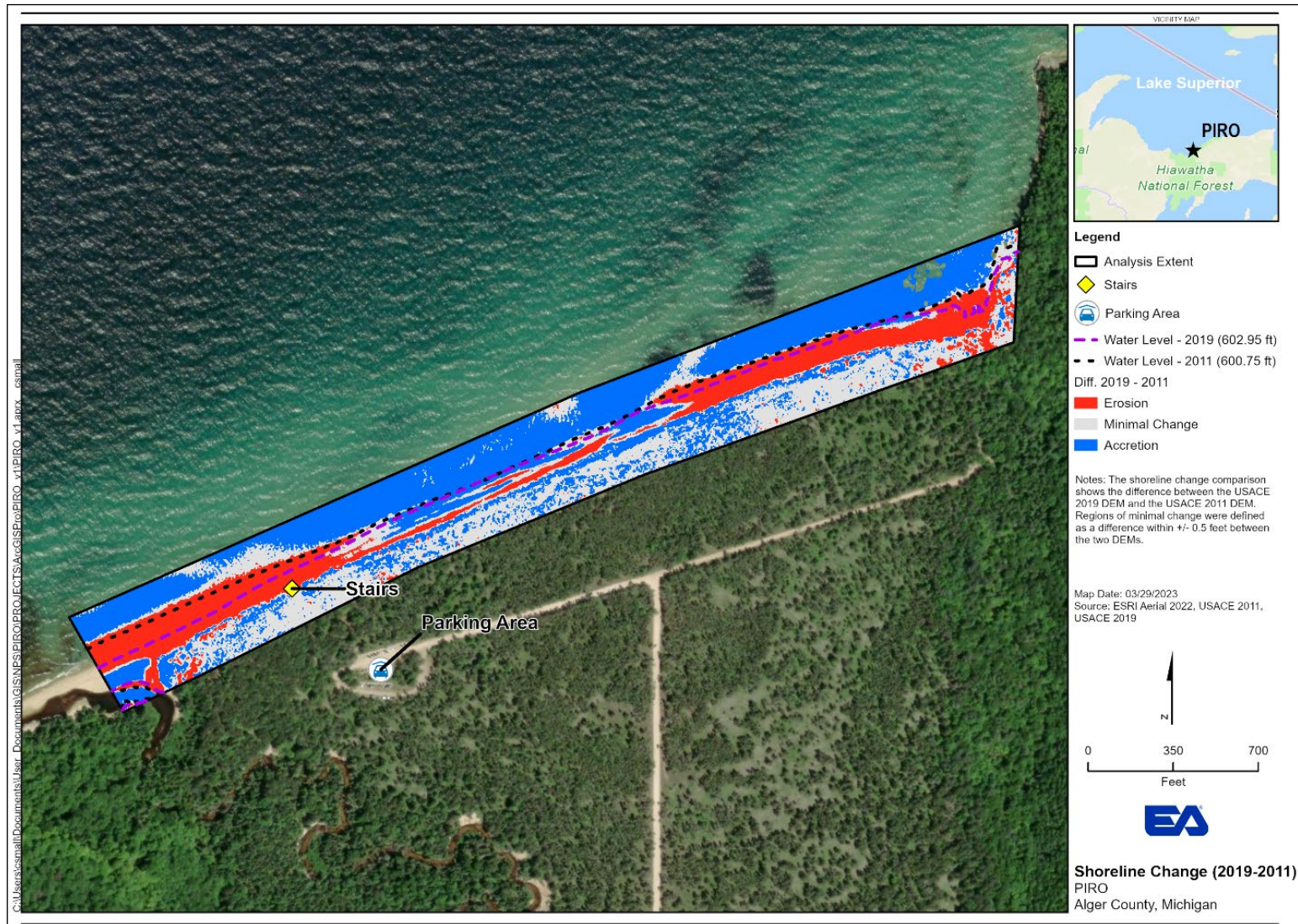
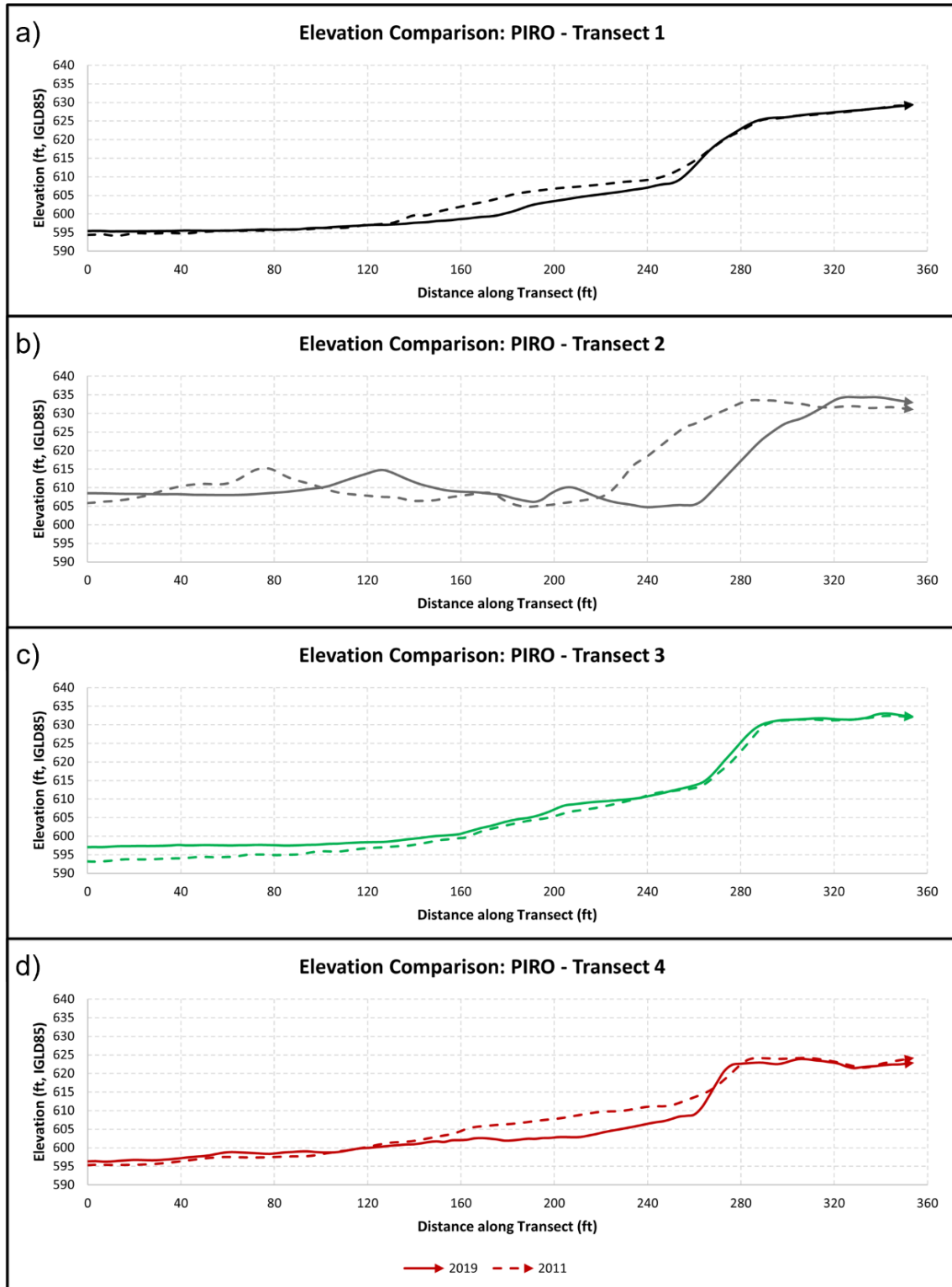


Figure 7 shows a comparison of the 2011 and 2019 profiles along the four transects.

Figure 7. Comparison of available elevation data along transects 1-4



In 2011, the top of the bluff near the stairs was approximately El. 625 feet (IGLD85), and the toe of the stairs was approximately El. 610 feet (IGLD85). The 2019 data show that the beach decreased by 3 feet at the toe of the stairs and by as much as 5 feet on the beach immediately seaward of the stairs. The top of the bluff remained relatively unchanged between 2011 and 2019 in the vicinity of the stairs. Transect 2 near the creek had the most dramatic change. The bluff retreated approximately 40 feet in the vicinity of transect 2. Note that further investigation and data review would be required to determine if this much change actually occurred or if there may be potential bias in the datasets in this location, but a review of historic aerials shows significant change in this area. Transect 3 did not experience much change between 2011 and 2019 and transect 4 shows a loss of about 5 feet on the beach immediately seaward of the bluff. It is anticipated that the shoreline change has had a negative impact on the stairs by allowing them to be more exposed to the storm forces generated by Lake Superior and by causing the toe to be undermined.

Water Levels and Storms

Water levels in Lake Superior and all the Great Lakes fluctuate due to precipitation, runoff, and evaporation. Water levels in Lake Superior also follow a seasonal cycle where water levels rise in the spring due to increased precipitation and increased runoff from snowmelt. In the summer, water levels typically reach their peak. In the fall, water levels generally decline due to an increase in evaporation as temperatures decline and cold air moves over the relatively warm lake waters. This trend can be seen in the daily mean lake water elevation data acquired from NOAA Tides and currents for the Marquette Coast Guard Station (ID 9099018) for the period 1980 to 2023 are shown in figure 8.

Analysis of current water levels shows that in recent years (2021-present), water levels in the lake have been generally above or at historic averages, but below the historic levels recorded between 2015 and 2020. Between 2015-2020 lake levels were well above average, and sometimes even at monthly record levels. The above average water levels during this time were due to above average precipitation and several years of high ice coverage. Prior to this, lake levels were below average from 1998-2013, largely due to warmer temperatures and high rates of evaporation (GLISA 2023c). The monthly range of max and mean water elevations throughout the period of record are shown in figure 9 and figure 10, respectively (NOAA 2023e).

Figure 8 shows that across the station's period of record the lowest observed lake level was 599.32 feet (IGLD85) and highest was 603.95 feet (IGLD85), resulting in a range of 4.63 feet. Monthly mean Lake level in 2022 ranged from 601.05 ft (IGLD85) in February to 602.63 feet (IGLD85) in September (a 1.58-foot range). Figure 8 shows that lake levels have oscillated across the period of record. There is no detectable upward or downward trend in lake level over the period of record.

USACE publishes Great Lakes Water Level Future Scenarios and outlooks for water levels in the lake. Their projections are based on the present condition of the lake basin and anticipated future weather. Figure 11 shows the projection for the next six months. The solid red line is the recorded level since March 2021, the dashed blue line is the average water level from 1918 to 2021, and the green dashed line is the projected water level over the next six months. The red cone surrounding the projected water levels shows the range of possible water levels based on predicted weather conditions. The historic maximum and minimum water levels over the period of 1918 to 2021 are also shown on figure 11 as black lines for each month. Figure 11 shows that water levels are predicted to be above average for the next six months, but within the historic lake range.

**Figure 8. Lake Superior hourly Water Surface Elevation for the Marquette Coast Guard Station (ID 9099018) (1980 – 2023)
(NOAA 2023e)**

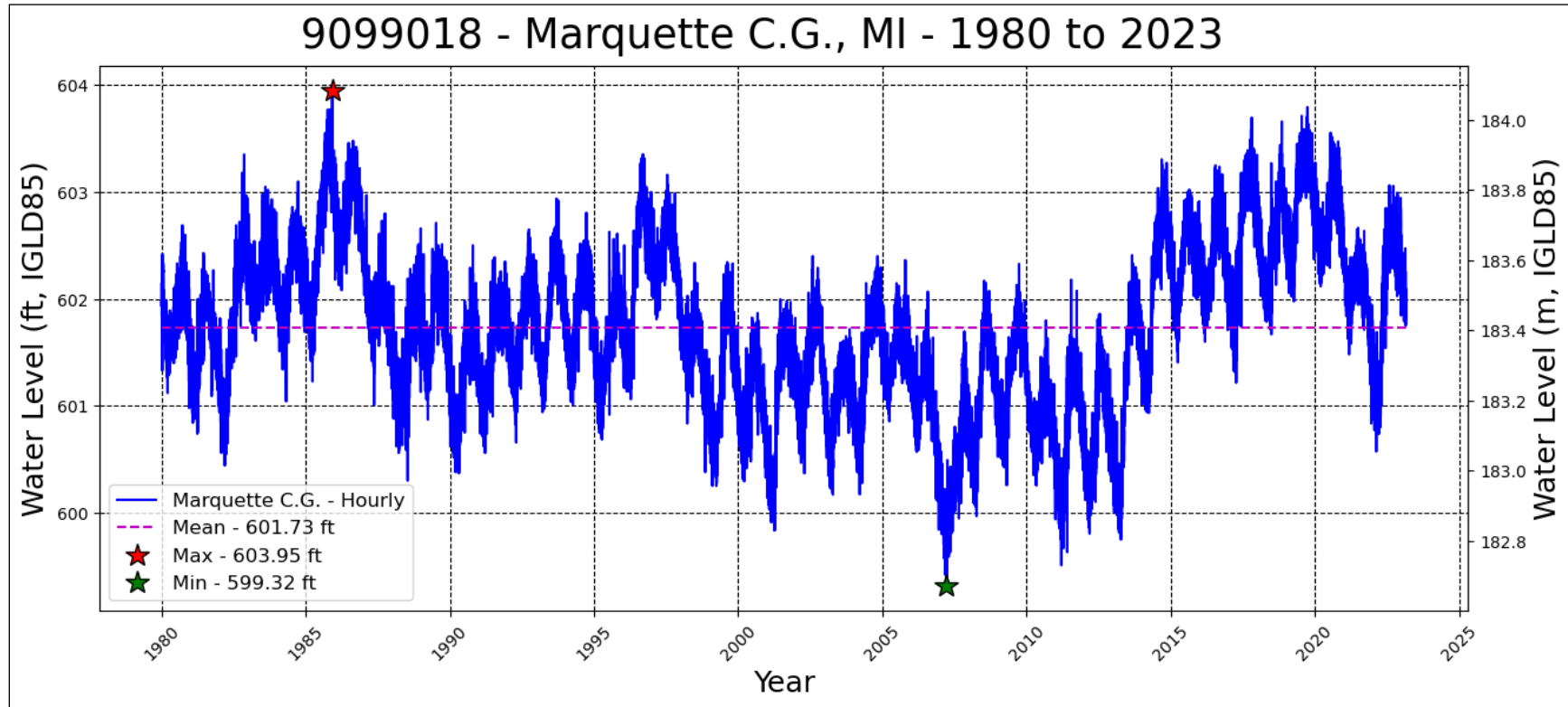


**Figure 9. Monthly Maximum Water Surface Elevation for the Marquette Coast Guard Station (ID 9099018) (1980 – 2023)
(NOAA 2023e)**

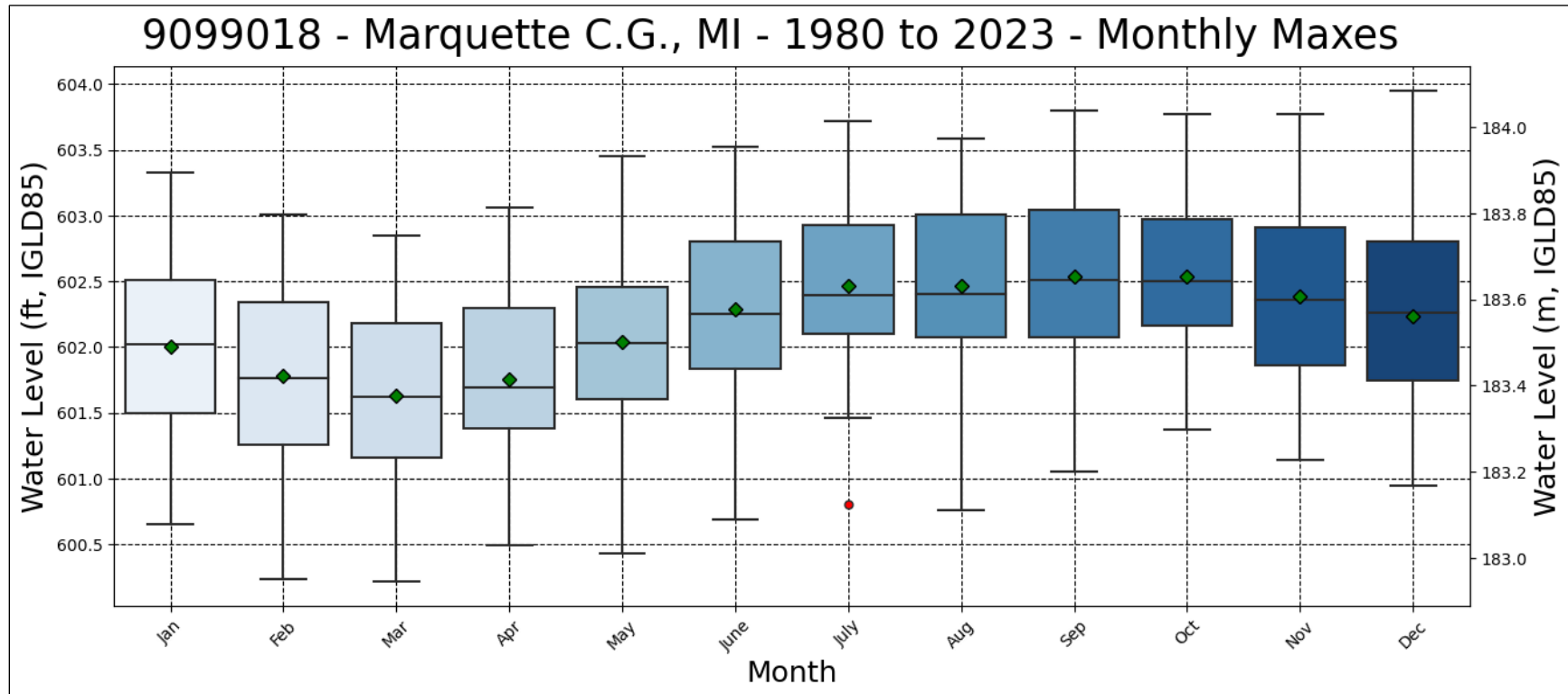


Figure 10. Monthly Mean Water Surface Elevation for the Marquette Coast Guard Station (ID 9099018) (1980 – 2023) (NOAA 2023e)

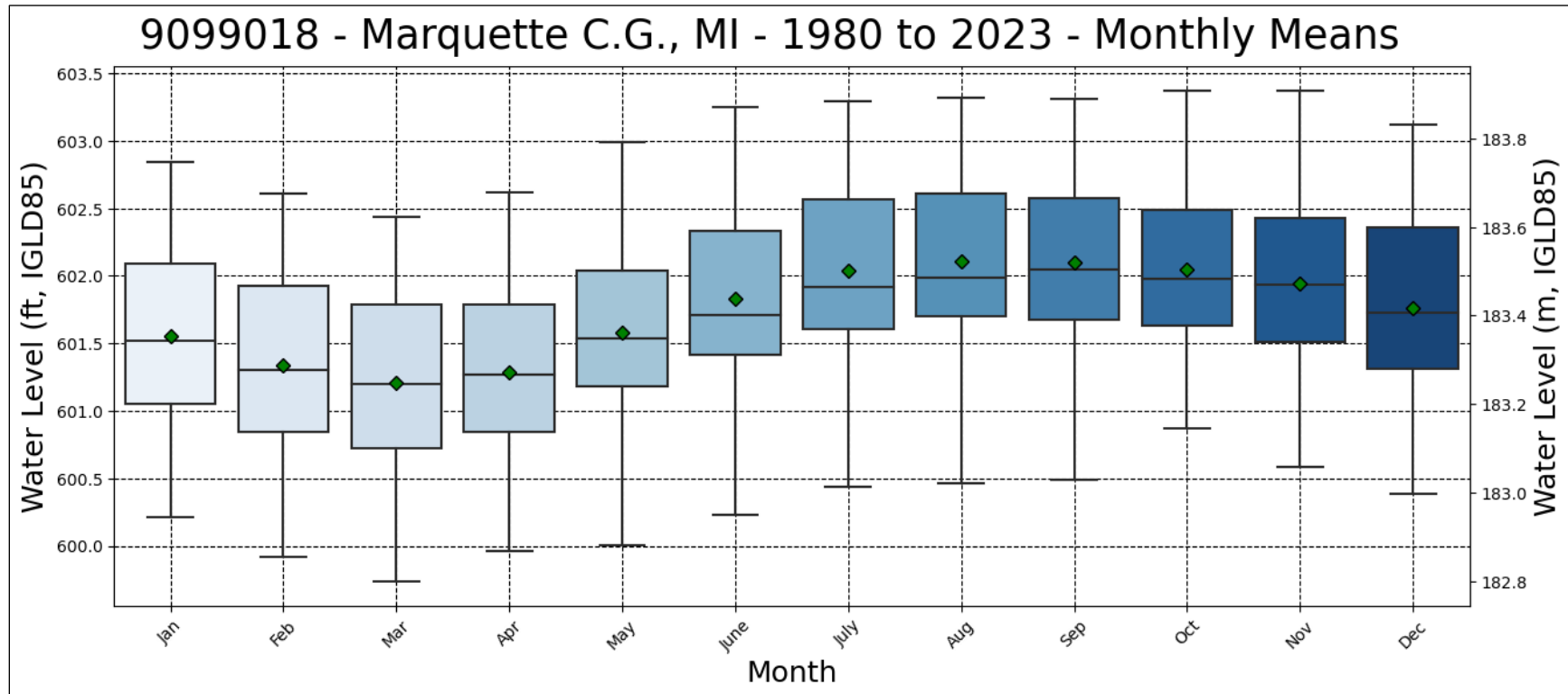
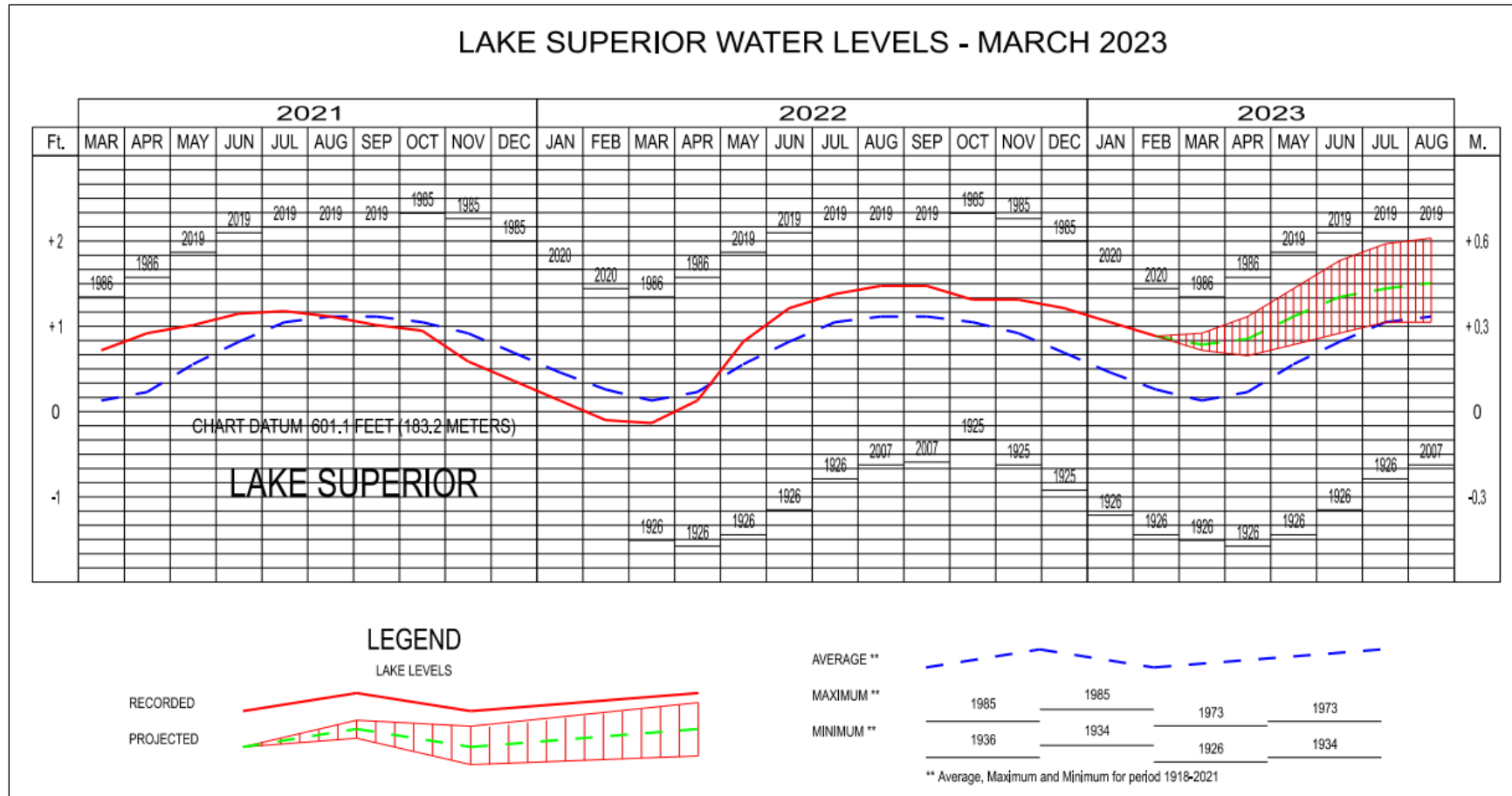


Figure 11. Six-Month Outlook for Lake Superior Water Level (USACE 2023)



It is anticipated that climate change will cause an increase in temperatures throughout the Great Lakes region. This would be expected to increase evaporation and decrease ice coverage, but an increase in precipitation has also been observed (GLISA 2023a, c). As such, there is uncertainty on how future climate change may impact lake levels (GLISA 2023b).

During the October 18, 2022 storm, the maximum recorded water level at the Marquette Tide Gauge was 603.0 feet (ILGD85). While this water level and the maximum recorded water level at the station are below the approximate elevation of the toe of the stairs (approximately El. 607 feet), the station is only measuring water levels and not wave action. In addition, the station is located on the south side of a peninsula and may not be capturing nearshore phenomena resulting from winds generated from the north, the primary direction impacting Miners Beach. These phenomena may include seiches, and/or wave setup and wave runup which are discussed in the following sections and defined below:

Seiches – A stationary or standing wave that oscillates back and forth. On Lake Superior, seiches are typically caused when winds create a change in atmospheric pressure causing water to rise on one side of the lake. When the wind stops, the water returns to the other side of the lake causing water levels to increase quickly.

Wave setup – An increase in water levels due to the presence of breaking waves.

Wave runup – The upper elevation limit of wave action above the water level. Wave runup typically occurs when a wave breaks and washes up the beach.

Wind and Waves

Miners Beach is generally subject to waves from the north, given the orientation of the shoreline to the east and Grand Island to the west. Wind blowing over Lake Superior generates waves. Wave height is affected by the wind speed, how long the wind blows (duration), and the distance over water the wind blows (fetch). As wind speed, duration, and fetch increase, so does the wave height. In addition, winds across Lake Superior may create changes in atmospheric pressures and create a phenomenon known as a seiche - French word that means “to sway back and forth.” While the tide range on Lake Superior is microtidal at less than 2 inches (NOAA 2023a), these wind-driven seiches cause water levels to rise on one side of the lake and then oscillate back to the other side once winds die down. Small seiches are typically unnoticeable, but large seiches can resemble storm surges. Seiches have been known to result in changes in nearshore water levels by as much as three or more feet in Lake Superior (NPS 2018a).

Wind and wave data were collected from the following data sets:

- Wind Data
 - Iowa State University’s archive of National Weather Service Station - Munising Lakeshore Observation (KP53) 2004 – 2023 (Iowa State University 2023a)
 - Iowa State University’s archive of Sawyer AFB in Gwinn Michigan 1970-2023 (Iowa State University 2023b)
- Wave Data
 - USACE’s Coastal Hydraulics Laboratory and Engineer Research and Development Center’s Wave Information Study (WIS) Data Portal – Station ST95055 (USACE 2022)

These were the closest wind and wave data to the site. This information was used to approximate the direction and magnitude of the wind and waves impacting the site. The Iowa State University – Iowa Environmental Mesonet was used to create windrose plots for the Munising Lakeshore Observation and Sawyer AFB stations (figure 12).

Both windrose plots show the highest wind speeds occur most frequently out of the northern quadrant. High winds occurring out of the northern direction will generate waves that can impact the site. The Sawyer AFB station also shows some strong winds generated out of the southernly direction. These winds may also impact the site as they have the potential to create seiches in the lake which can cause lake levels to rise and fall.

The data from the WIS Station ST95055 were used to predict the wave height impacting the site. The WIS is a hindcast, or calculation of likely past nearshore wave conditions at the site based on historic environmental conditions. The WIS station storm event return period wave hindcast is shown below in figure 13.

Figure 13 shows that in October of 2017, waves in excess of 22 feet (6.8 meters) likely occurred in the nearshore of the site. The top 10 wave events show wave propagation out of the north or northwest towards the site. The 100-year return period significant wave, which has a 1% chance of occurrence in any given year, is predicted to be 26 feet. Figure 13 also shows that waves in excess of 15 feet (4.8 meters) can be anticipated on an annual basis (1-year return period).

When these waves propagate towards the shore, they will transform and break when the water gets too shallow. These breaking waves often cause the water level to rise. This increase in the water level due to the breaking waves is known as wave setup. Once the wave reaches the shore, it may wash up the beach in a phenomenon known as wave runup. Wave runup is the upper elevation limit of wave action above the water level. Although the maximum observed water level does not exceed the toe of the stairs, preliminary wave setup and runup calculations predict that wave action will reach the toe of the stairs at least on an annual basis.

Ice

Ice can create vertical and horizontal forces on marine structures and will need to be accounted for in any future stair design. In addition, it may contribute to scour and erosion along the shoreline. As seen in figure 14, ice dramatically affects the shoreline in this area.

Ice formation impacts climate patterns, lake water levels, water movement patterns, water temperature structure, and spring plankton blooms (NOAA 2023b). Over the past 20-30 years, the lakes have experienced less ice coverage than in earlier years. Air temperature is the main factor affecting ice coverage, but there remains strong variability year-to-year and high ice winters are still possible. Though the long-term projections for water levels in the lake are unclear, years with low ice coverage increases evaporation potential from the surface of the lake and in the absence of an increase in precipitation, may lead to a long-term decline in lake levels (GLISA 2023a).

Ice coverage in the winter of 2022-2023 was significantly below average (NOAA 2023d). Figure 15 shows the average ice concentration across the Lake from 1973-2023. The maximum ice coverage year (1996) is shown in red, and the minimum ice coverage year (2012) is shown in green. 2023 is shown in black. All other years are shown in purple. The figure shows that 2023 was one of the lowest ice coverage years since the period of record began in 1973.

Figure 12. Windrose plots for Munising (2004-2023) and Sawyer AFB (1970-2023) (Iowa State University 2023a&b)

Note: This figure uses meters to display wave height. The conversion from meters to feet is 1 meter = 3.28 feet. For reference, 3 meters is 9.84 feet, 6.8 meters is 22.30 feet, and 8 meters is 26.24 feet.

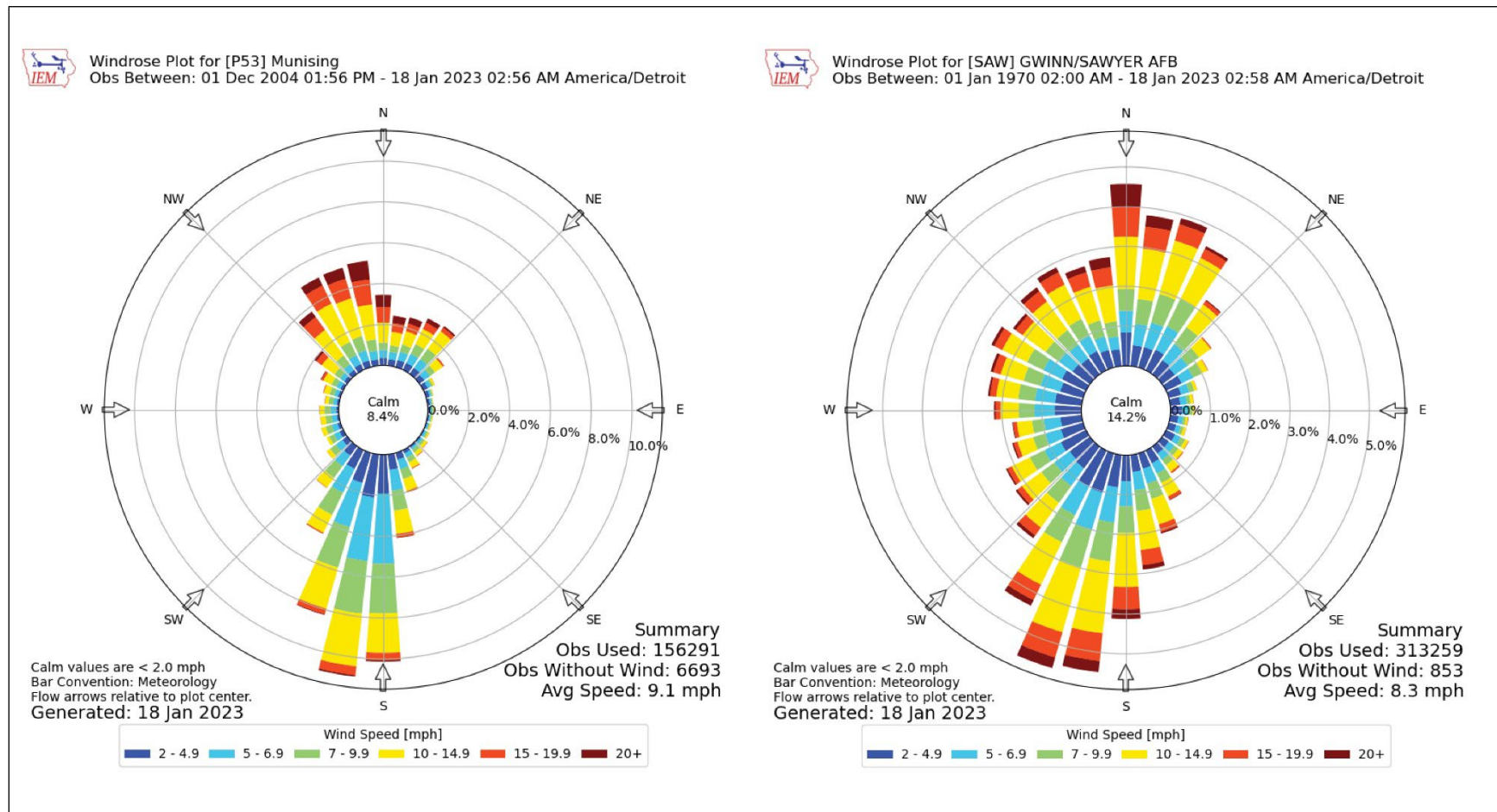


Figure 13. The WIS station storm event return period wave hindcast (USACE 2022)

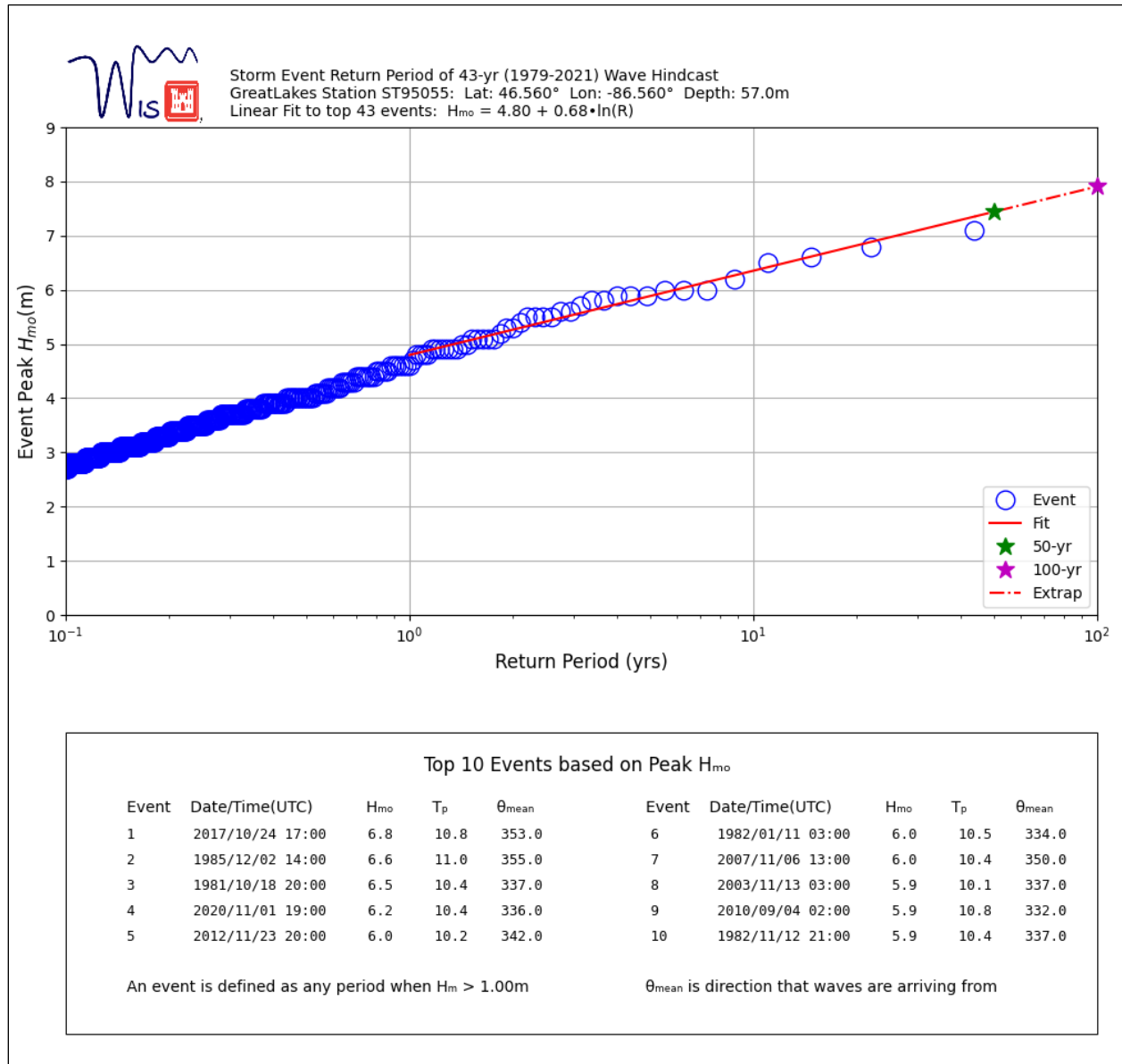


Figure 14. View from Miners Beach towards the cliffs and Bridalveil Falls (NPS 2018b)



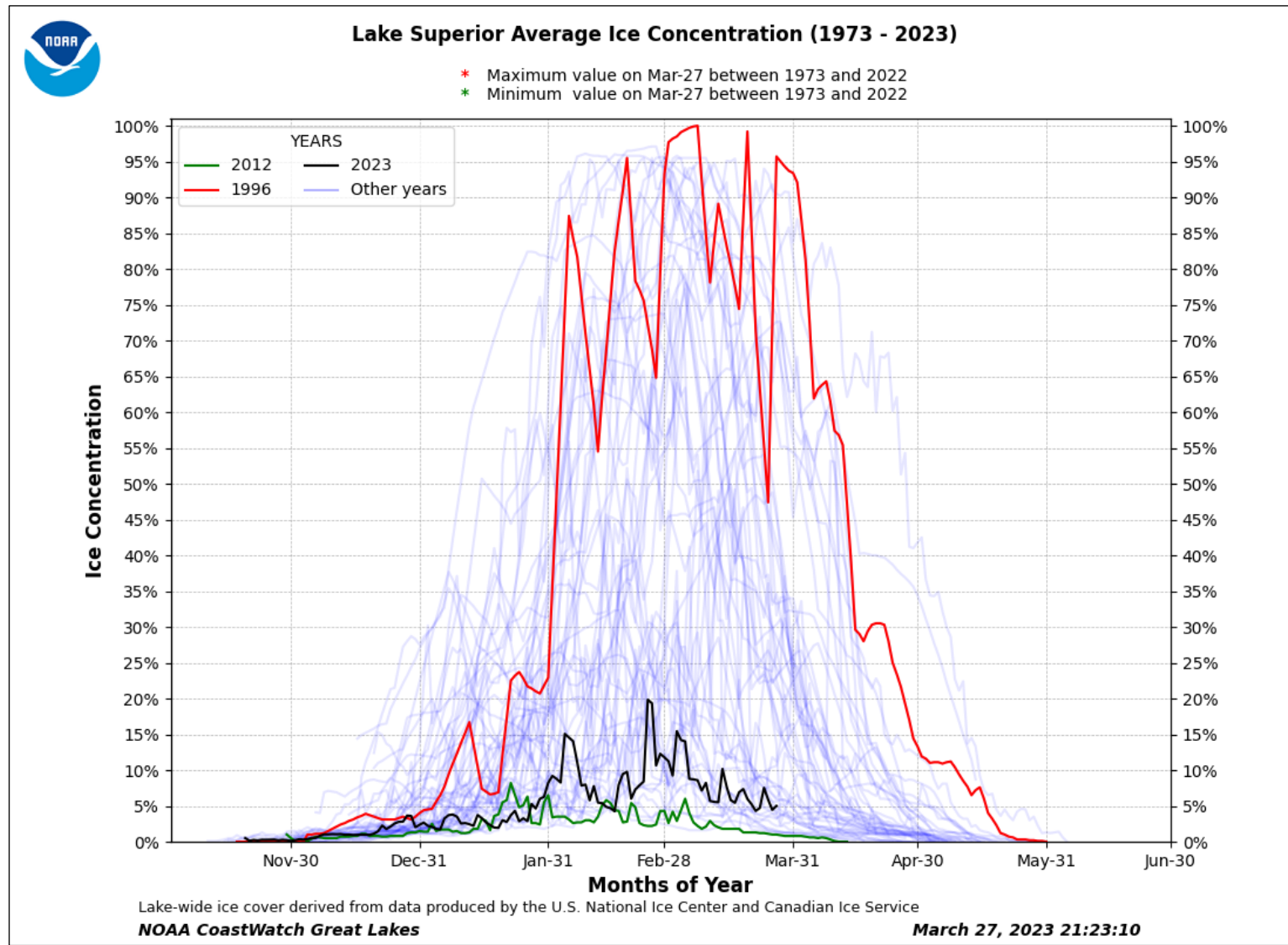
Climate

Climate change affects water levels, precipitation, and ice formation on the Great Lakes. Water level fluctuations are mainly driven by precipitation, evaporation, and runoff. In recent years, warmer surface water temperatures have contributed to lowering water levels by increasing rates of evaporation and causing lake ice to form later than usual, extending the season for evaporation. Greater evaporation over the Great Lakes is linked to increased precipitation on average in the region down wind of the lake (GLISA 2023a).

PIRO has not been directly in the path of a hurricane-strength storm in the last century, but an increased risk in high intensity storm events over the coming century is anticipated (Caffrey 2015). Changes in lake levels coupled with more intense storms may lead to shoreline change through erosion and/or accretion. Per the review of elevation data discussed in the previous sections, erosion has been observed at this site.

It is predicted that climate change impacts to weather patterns will impact lake levels, but there is not a clear consensus on how. Higher average temperatures will lead to lower ice coverage and higher evaporation rates which can cause lake levels to decrease. Conversely, the frequency and intensity of rain events are expected to increase which can increase lake levels. Currently, the strongest evidence indicates increasing variability in Lake level fluctuations (GLISA 2023a).

Figure 15: Lake Superior average ice concentration (1973-2023) (NOAA 2023c)



Summary

The timber stairs are located on a sandy beach that is regularly impacted by strong wind and waves. Per data presented above, it is anticipated that the factors contributing to stair failure are:

- Stairs are regularly impacted by forces produced from the waters, wind, waves, and ice generated in Lake Superior during storm events.
- The beach in front of the stairs has been subject to erosion causing an undermining of the toe.

Trends in water levels, storm events and climate suggest that the environmental factors will not improve in the future, and if re-built in-kind/in-place, the stairs will continue to fail.

ALTERNATIVES AND RECOMMENDATIONS

Proposed alternatives for replacing the stairs are provided below. Each alternative has a narrative describing the proposed alternative and whether it is recommended. For preliminary planning purposes a rough cost range is provided (table 1), however, these ranges will need to be refined through future design. The ranges provided include estimates based on assumed quantity, takeoffs determined using the best available data and site assumptions, but many of these variables are yet to be determined. It is anticipated that actual conditions will vary as the design is advanced and more data are obtained from the site, thus, these estimates are subject to change.

Table 1. Preliminary Range of Costs

Range	Cost
Low	Likely < \$ 50k
Medium	Likely \$ 50k-150k
High	Likely > \$ 150k

1. Do nothing/re-build in-kind – The “do nothing” alternative would involve replacing the stairs in timber to their original footprint, in-kind. While this alternative would provide access to the beach, the water level, wind, and wave study show that it is predicted that the toe of the stairs is vulnerable to storm forces annually. The repetitive damage to the stairs indicates that their current design is not adequate to survive the forces generated from the waters, wind, waves, and ice that occur in Lake Superior. If the stairs were to be replaced in-kind, it is anticipated that they would be damaged again leaving the park with no access to the beach for extended periods of time. This alternative may not be desirable due to the high volume of visitors that PIRO receives and because stable access is needed to Miners Beach, but it may be considered to provide short term access to the beach while the park develops a plan to provide a long-term solution. If there is no park-provided access or this access is intermittent, visitors would likely find their own way down to the beach, causing erosion and safety problems. In addition, when the stairs are inevitably damaged again, they could become an attractive nuisance leaving the park liable if visitors attempt to use the damaged stairs. The “do nothing” alternative could create a safety risk for the visitors, a liability for the park, and limits access to Miners Beach and its water dependent uses such as swimming, kayaking, etc. While this alternative could be more cost-effective than other alternatives, it is not recommended for long-term planning due to the damage previous stairs have sustained. It is estimated that costs for this alternative would be in the medium range.

2. Remove the stairs – This alternative would involve removing the stairs in their entirety. This alternative would limit access to Miners Beach and its water-dependent uses. Like the “do nothing” alternative, if there is not park provided access, visitors would likely find their own way down to the beach, causing erosion and safety problems. As such, this alternative is not recommended. It is estimated that costs for this alternative would be in the low range.
3. Relocate stairs – This alternative would involve relocating the stairs to another location. The review of the 2011 and 2019 elevation data show that much of the beach was subject to erosion during that time frame. The elevation data presented above shows that the beach decreased by 3 feet at the toe of the existing stairs and by as much as 5 feet on the beach immediately seaward of the existing stairs between 2011 and 2019. If the stairs were to be relocated, it is recommended that they be relocated to a stable area of the beach. The change in the profile near the creek (transect 2) had the most dramatic change. The bluff retreated approximately 40 feet in the vicinity of the creek. The area located approximately 3,000 feet to the east of the existing stairs (transect 4) shows a loss of about 5 feet on the beach immediately seaward of the bluff between 2011 and 2019. However, there is evidence of exposed ledge near transect 4 which may assist in anchoring the stairs such that they can resist the forces generated across Lake Superior. The area located approximately 1,500 feet east of the existing stairs (transect 3) appeared to be of similar elevation in 2011 and 2019 indicating that it was relatively stable during this time. In addition, the grade at the toe of the bluff near transect 3 is about 5-10 feet higher than the other transects, making the beach in front of transect 3 more capable of absorbing wave energies and reducing forces. This alternative could require the addition of new trails based on access needs. If this alternative were to be chosen, the locations in the vicinity of transect 3 and 4 could be considered. Further analysis to refine the location is recommended. This alternative may be considered in conjunction with Alternative 4 or 5 described below. It is estimated that costs for this alternative would be in the medium to high range depending on what other alternatives are considered in conjunction with relocation.
4. Robust stair design – This alternative would include developing environmental forces associated with a design criteria and basis of design and designing the stairs to resist those forces. Typically, the 100-yr return period storm event is the recommended design criteria. This alternative could involve replacing the stairs in place or at another location as discussed above. No design for this alternative has been performed but based on the observed damage of the existing stairs, this alternative may require the stairs to be made of a stronger material such as concrete foundation and/or steel or aluminum frame to resist the wave forces. In addition, piles and a concrete foundation may be required to resist the forces. This alternative would likely be the highest cost alternative, but it would be more resilient than other alternatives. Figure 16 shows an example of what these stairs might look like.

To reduce the forces, and reduce the amount of structure required, break-away or flow-through stair treads could be considered. If break-away treads are chosen, stair treads may need to be replaced following storm events.

The primary benefits of this alternative would be safe and resilient access to the beach. These stairs would be designed to resist forces associated with a design storm event. They would reduce the amount of maintenance that is currently required to repair the existing stairs, however the beach grade at the toe of the stairs would need to be maintained. It is estimated that the cost for this alternative would be in the high range.

5. Removable Stairs – This alternative involves replacing the existing stairs with stairs that are retractable in the event of a storm or high-water level event. Since the existing bluff is over 18 feet high, the entire staircase being removable is not practical. As such, a platform could be installed at an elevation above a design storm event and the removable stairs extend down to the beach from the platform. For example, the 100-yr return period storm event could be used. Figure 17 shows an example of a modular stair installation on a beach. It is anticipated that this alternative will be more costly than alternatives 1-3, but less costly than alternative 4.

In addition to providing resilient access to the beach, this alternative would be easily adapted to the changing beach grade. If the beach loses grade over the years, instead of replacing the entire system, it may be possible to replace the removable section with a longer section. There would be a maintenance cost associated with this alternative. The drawbacks include the need to monitor weather events and remove the stairs in the event of a predicted storm or high-water level event. In addition, the existing stairs appear to be approximately 6 feet wide. Since the removable stairs would need to be lightweight, the overall width of the stairs would be limited. It is estimated that costs for this alternative would be in the high-cost range.

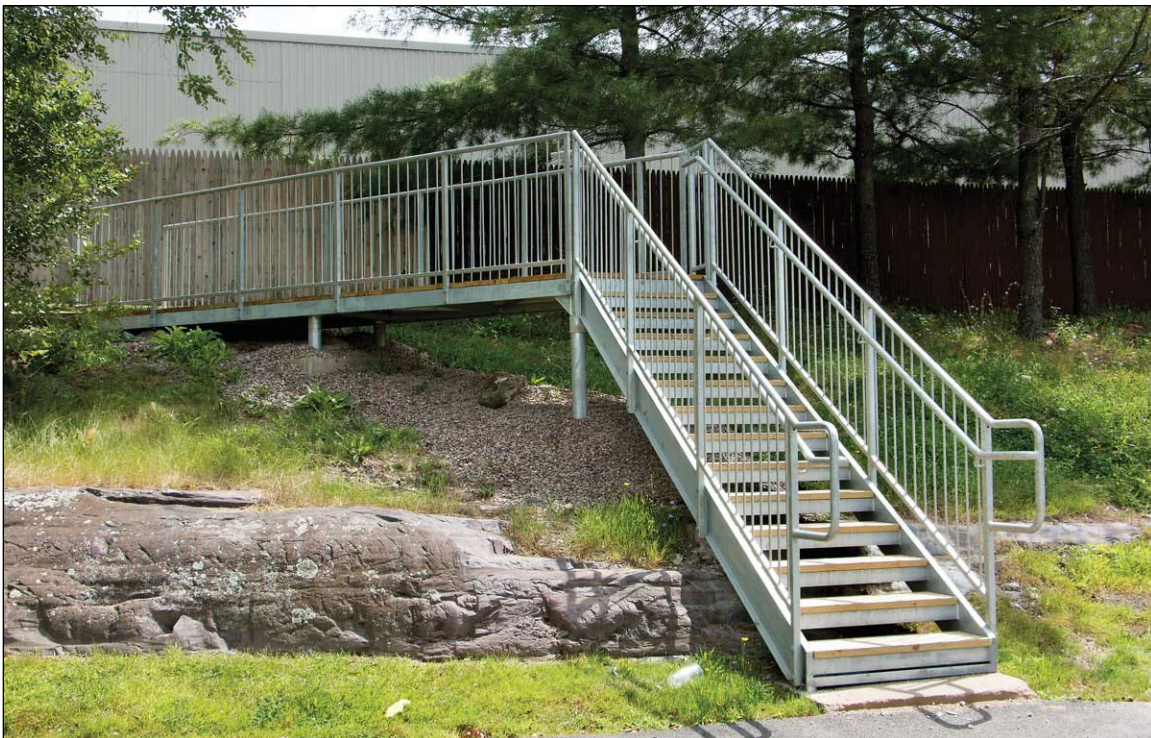
6. Protection Measures – This alternative includes installing a protective measure such as rip-rap toe protection or a seawall to protect the toe of the stairs. Given the dynamic nature of the beach, this alternative is not recommended by itself, however, could be used to fortify alternative 3, 4 or 5. Examples of this alternative include placing armoring around a proposed structure's foundation or the toe of the structure. It is estimated that this alternative would cost in the medium to high range depending on the length and size of the proposed structure.
7. Hybrid Approach – This approach involves blending two or more of the alternatives listed above.

Since the current configuration of the stairs is regularly damaged, a different solution is advised. Alternatives 4 and 5 are the best alternatives to maintain long term access to the beach. These alternatives could be installed in conjunction with alternatives 3 or 6. Alternative 1 is recommended for long-term access but could be considered to address short-term needs. Alternative 2 is not recommended.

Figure 16. Commercial Stairs (Dock Doctors LLC 2020)



Figure 17. Removable stairs (Great Northern Docks 2020)



CONCLUSIONS

Miners Beach is popular for park visitors. Historically, a set of timber stairs has been used to access the beach from the North Country Trail; however, these stairs have been frequently damaged. The 18 October 2022 storm rendered these stairs unusable. Due to the high volume of visitors that PIRO receives, stable access is needed for Miners Beach. Site geology, elevation, aerial imagery, climate, wind, wave, water level, storms, ice, and climate factors were reviewed to assess what environmental conditions were influencing the damage to the stairs. It was determined that while lake levels remain below the toe of the stairs, the highly dynamic nature of the site has left them vulnerable to environmental forces from wind and waves. A preliminary analysis of wave setup and runup predicts that wave action will reach the toe of the stairs at least on an annual basis. In addition, the elevation data show that the beach lost a significant amount of elevation and width between 2011 and 2019, but there is uncertainty as to whether this trend will continue as lake levels fluctuate with the changing climate.

Of the alternatives discussed above, it was determined the following short-term and long-term strategies could be pursued at Miners Beach.

Short-term options:

1. Re-build in-kind – This alternative would restore access to the beach in a quick and cost-effective manner, but it is not sustainable in the long term. This alternative could be pursued if the park is looking to restore access to the beach quickly and at relatively low cost (compared to long-term options). There is a relatively high probability that a storm would impact the site and damage the stairs, similar to previous events described above. If the stairs are replaced in-kind at this time, measures may still be implemented to begin planning for a sustainable long-term solution, resistant to storm damage.

Long-term options:

1. Robust stair design – This alternative would require a higher initial cost than re-building the existing stairs, but would provide resilient, long-term access to the beach and reduce future maintenance. This alternative could also be considered with the re-location alternative as the areas near transect 3 or 4 may be better situated to absorb forces generated from Lake Superior.
2. Removable stair design – This alternative would require a higher initial cost than re-building the existing stairs in-kind, but likely a lower cost than the robust stair design alternative. While it could reduce maintenance requirements, it would require the park staff to monitor the weather and lake conditions and remove the lower portions of the stairs prior to storm events. This alternative could also be considered with the re-location alternative.
3. Relocation of the stairs – The cost and maintenance considerations for this alternative will vary depending on what other alternatives are considered in conjunction. Relocation of the stairs may help the proposed robust or removable stair design absorb forces generated from Lake Superior and could be considered with either of these long-term repair options.

These alternatives should be reviewed alongside the goals and objectives of the park to determine which alternative may provide the best opportunity going forward when considering the current and projected environmental conditions at the site.

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