Provenance Study of Spruce in Iceland

Mai Duong (mld6@hi.is)

Supervisors: Brynjar Skulason & Mariana Tamayo
School of Engineering and Natural Sciences

60 ECTS

skógræktin
ICELANDIC FOREST SERVICE

HÁSKÓLI ÍSLANDS

Research Questions

- Which types of spruce and their original sources are the most successful for afforestation efforts?

- What environmental and climatic conditions are best for optimal tree growth of spruce in Iceland?

Provenance Origins

Tatiklek

Icy Bay

Duck Mtn.

Chiniak

Yakutat

Port Chatham & Homer

Sitka & White Sulphur Springs

Phantom Rd.

Rennell Sound

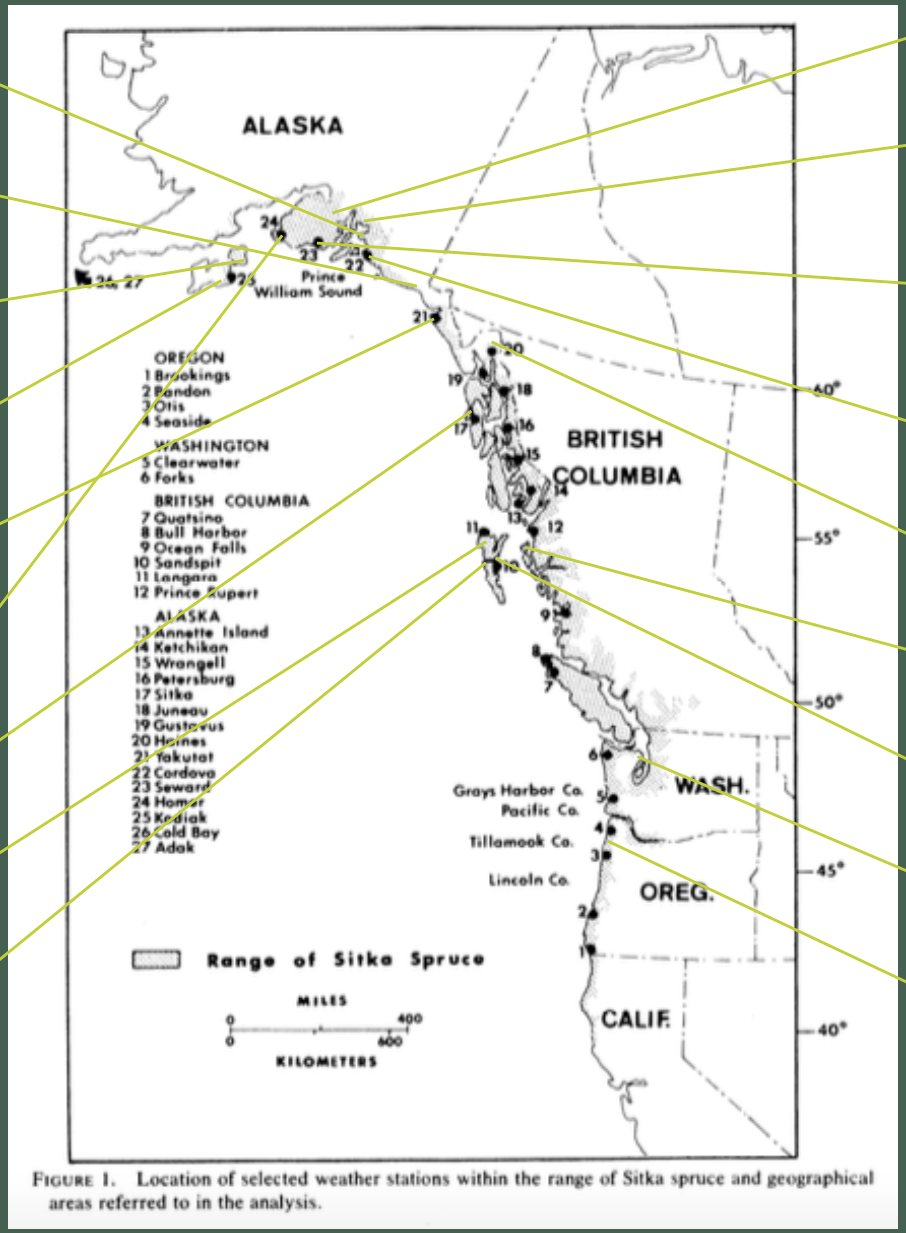


FIGURE 1. Location of selected weather stations within the range of Sitka spruce and geographical areas referred to in the analysis.

Portage to Girdwood

Valdez

Resurrection River & Nash Rd.

Cordova

Dyea & Haines Hwy.

Porcher Island

Queen Charlotte

Discovery Bay

Cannon Beach

(Modified Figure 1 from Farr & Harris, 1979)

Provenance Origins

Knik River (SB)

Chinitna Bay & Iniskin Bay (SG/SB)

Ninilchik (SB/HG)

Kenai Lake (SB), Cooper Lake & Moose Pass (SB/SG)

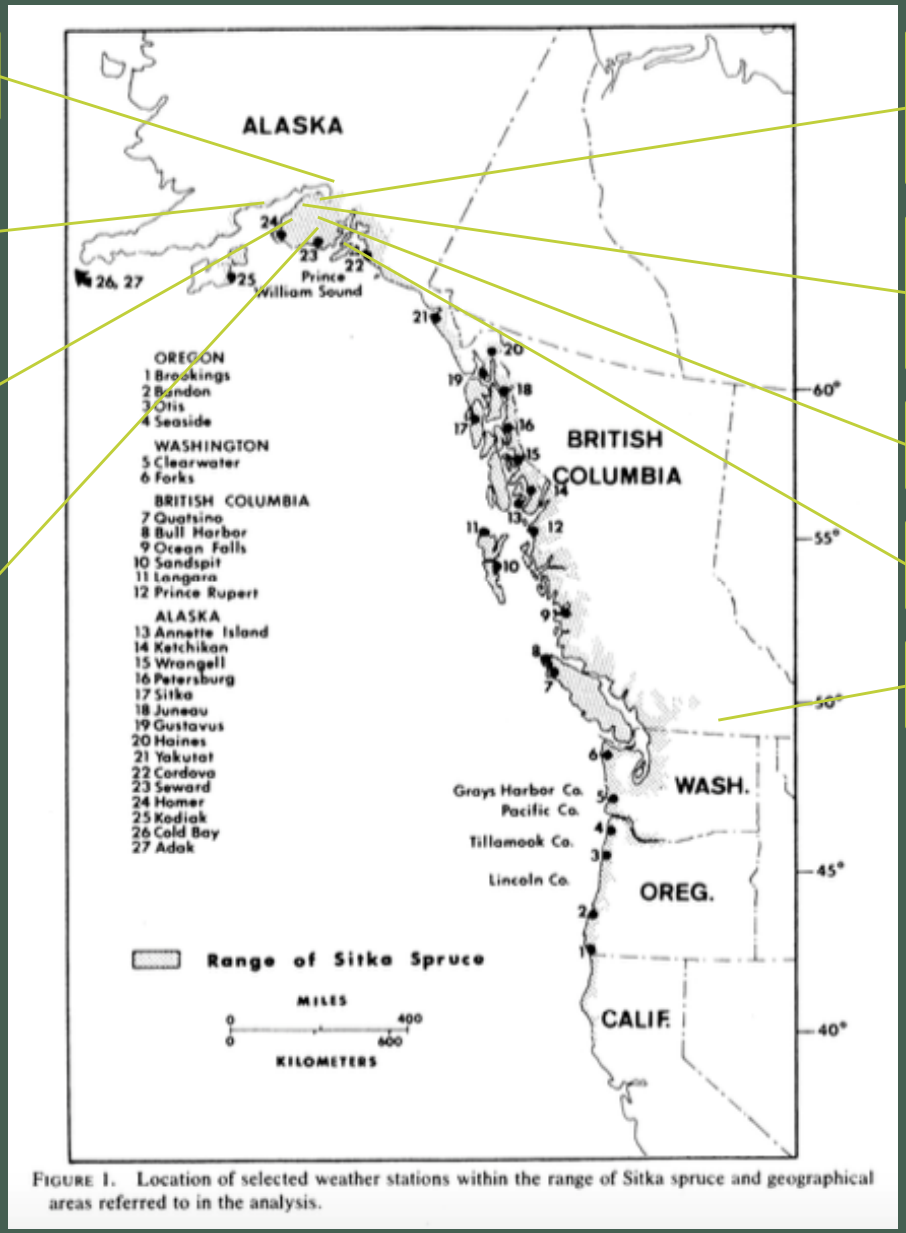


FIGURE 1. Location of selected weather stations within the range of Sitka spruce and geographical areas referred to in the analysis.

Hope (HG/SB) & Hope Rd. (SB)

Kenai (HG) & Soldotna (SvG)

Summit Lake (SB)

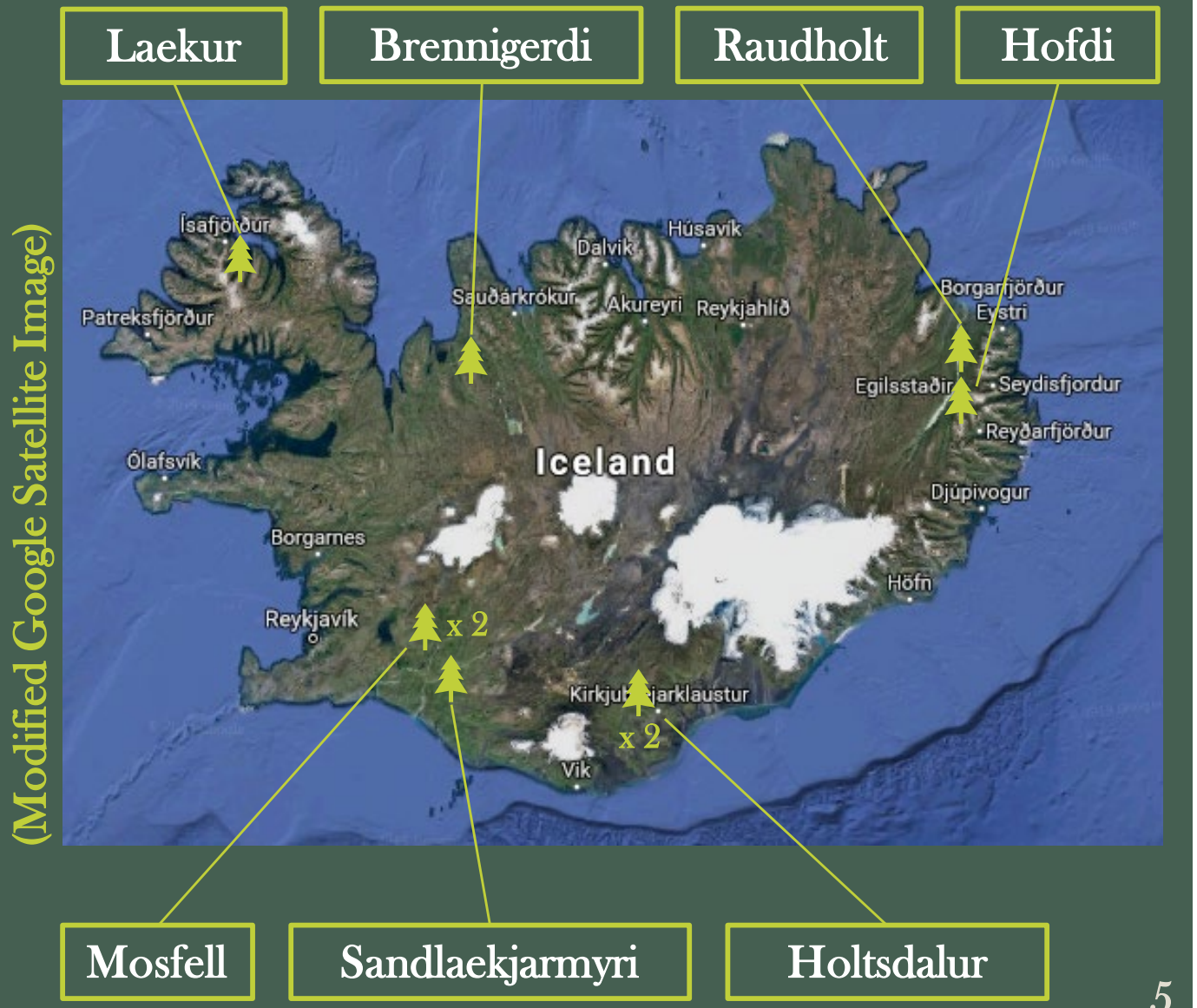
Snug Harbor (SB)

Bluejoint Mtn. (BG)

(Modified Figure 1 from Farr & Harris, 1979)

Methodology

- Data collection from 9 field sites
  - Height, diameter, form
- Volume calculation
- Comparison of provenances within sites and between sites



Preliminary Results Outline

- Combined Holtsdalur95 and Mosfell Peatland
- Holtsdalur95 Only
- Mosfell Peatland Only
- Combined Mosfell Peatland, Sandlaekjarmyri, Laekur, and Hofdi

Preliminary Results

- Combined Analysis of Holtsdalur95 and Mosfell Peatland
  - Examined common provenances

Table 1: Overall Survival Rate and Average Height Growth

Site	Alive	Dead	Survival Rate	Avg. Height
Holtsdalur95	2363	757	76%	348 cm
Mosfell Peatland	1523	2377	39%	175 cm

Preliminary Results

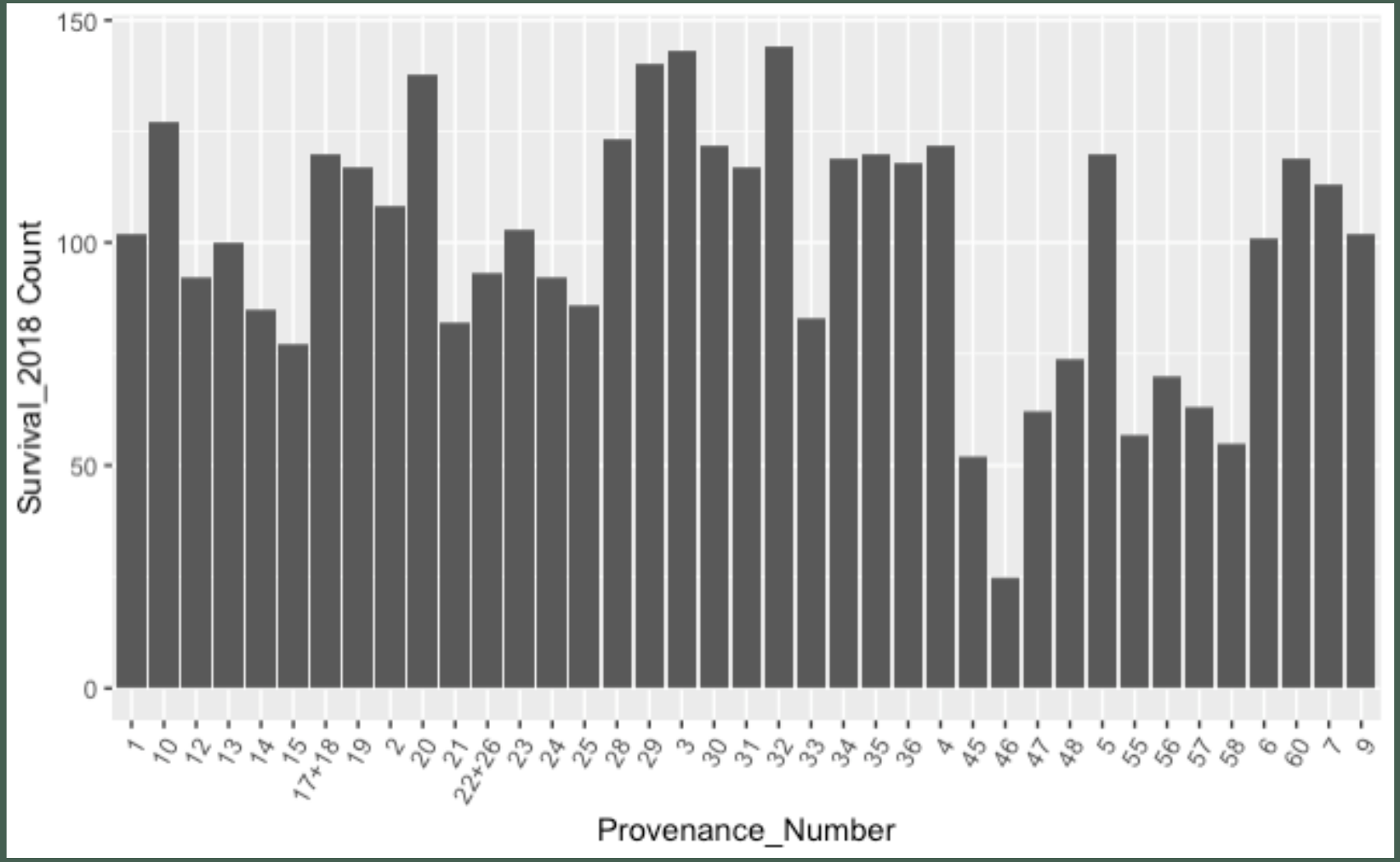
- **Statistical Analysis (combined Holtsdalur95 and Mosfell Peatland)**

Table 2: P-Values for the Correlations of Survival and Height Growth with Multiple Factors

Factor	Correlation with Survival	Correlation with Height Growth
Site	<0,001	<0,001
Provenance	<0,001	<0,001
Site * Provenance	<0,001	<0,001

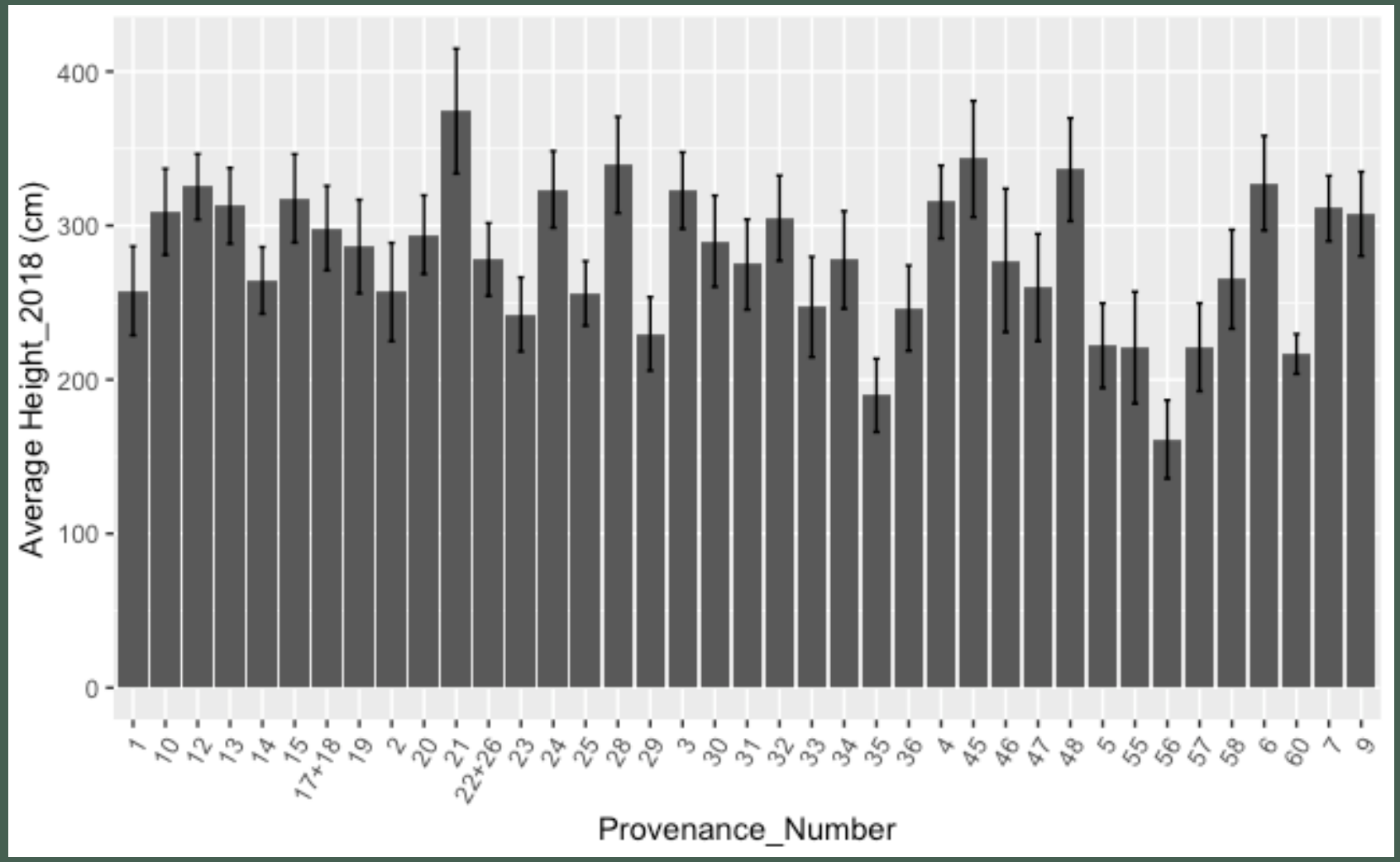
Preliminary Results

Figure 3: Comparison of Provenance Survival of Holtsdalur95 and Mosfell Peatland Combined



Preliminary Results

Figure 3: Comparison of Provenance Height Growth of Holtsdalur95 and Mosfell Peatland Combined



Preliminary Results

Table 3: Top 5 Provenances for Survival
(Combined Holtsdalur95 and Mosfell Peatland)

Provenance Number	Name	Species	Survival Rate	Avg. Height
32	Taraldsoy	SG	80%	305 cm
3	Iniskin Bay	SG/SB	79%	323 cm
29	Yakutat	SG	78%	230 cm
20	Cordova	SG	77%	294 cm
10	Nash Rd.	SG	71%	309 cm

Preliminary Results

Table 4: Top 5 Provenances for Height Growth
(Combined Holtsdalur95 and Mosfell Peatland)

Provenance Number	Name	Species	Avg. Height	Survival Rate
21	Icy Bay	SG	374 cm	46%
45	Phantom Rd.	SG	343 cm	29%
28	Dyea	SG	339 cm	68%
48	Rennell Sound	SG	336 cm	41%
6	Homer	SG	328 cm	56%

Preliminary Results

- **Analysis of Only Holtsdalur95**

  Table 5: Overall Survival Rate and Average Height Growth

Site	Alive	Dead	Survival Rate	Avg. Height
Holtsdalur95	2374	826	74%	349 cm

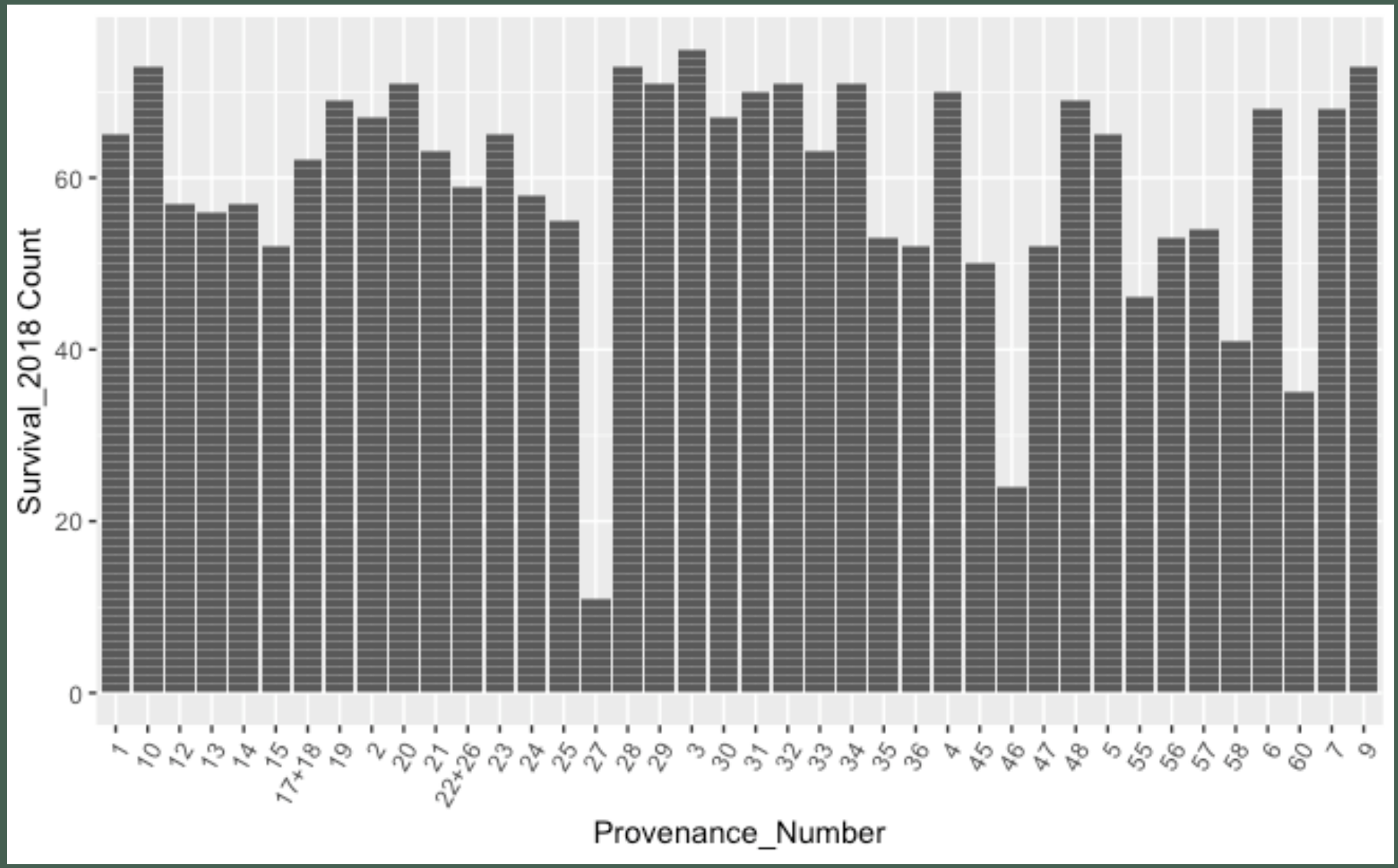
- **Statistical Analysis**

  Table 6: P-Values for the Correlations of Survival and Height Growth with Provenance

Factor	Correlation with Survival	Correlation with Height Growth
Provenance	<0,001	<0,001

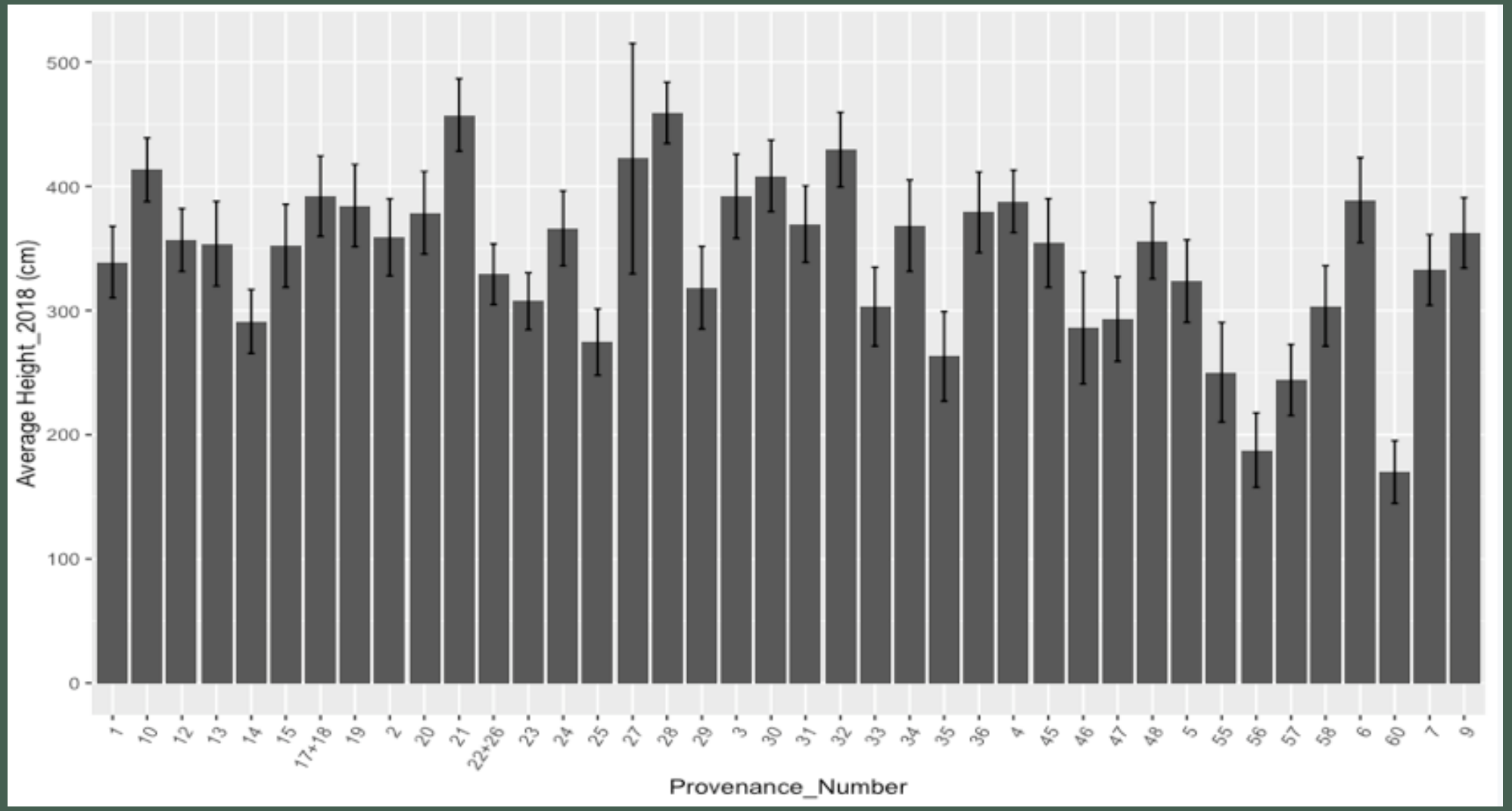
Preliminary Results

Figure 4: Comparison of Provenance Survival Within Holtsdalur95



Preliminary Results

Figure 5: Comparison of Provenance Height Growth Within Holtsdalur95



Preliminary Results

Table 7: Top 5 Provenances for Survival (Only Holtsdalur95)

Provenance Number	Name	Species	Survival Rate	Avg. Height
3	Iniskin Bay	SG/SB	94%	392 cm
10*	Nash Rd.	SG	91%	413 cm
9	Resurrection River	SG	91%	363 cm
28*	Dyea	SG	91%	459 cm
32*	Taraldsoy	SG	89%	430 cm

Preliminary Results

Table 8: Top 5 Provenances for Height Growth (Only Holtsdalur95)

Provenance Number	Name	Species	Avg. Height	Survival Rate
28*	Dyea	SG	459 cm	91%
21	Icy Bay	SG	457 cm	79%
32*	Taraldsoy	SG	430 cm	89%
27	Skotland	SG	422 cm	14%
10*	Nash Rd.	SG	413 cm	91%

Preliminary Results

- **Analysis of Only Mosfell Peatland**

  Table 9: Overall Survival Rate and Average Height Growth

Site	Alive	Dead	Survival Rate	Avg. Height
Mosfell Peatland	1751	2649	40%	186 cm

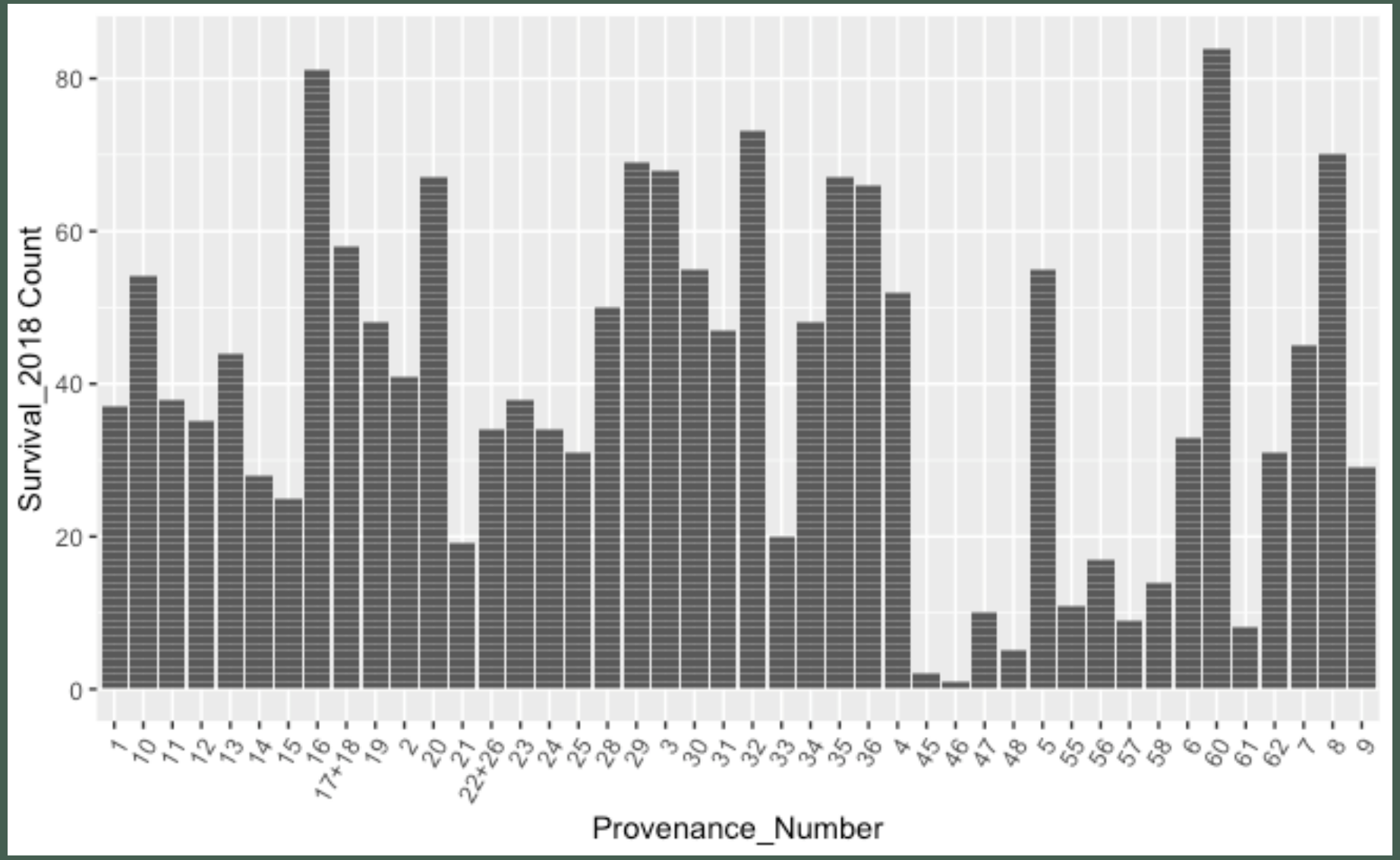
- **Statistical Analysis**

  Table 10: P-Values for the Correlations of Survival and Height Growth with Provenance

Factor	Correlation with Survival	Correlation with Height Growth
Provenance	<0,001	<0,001

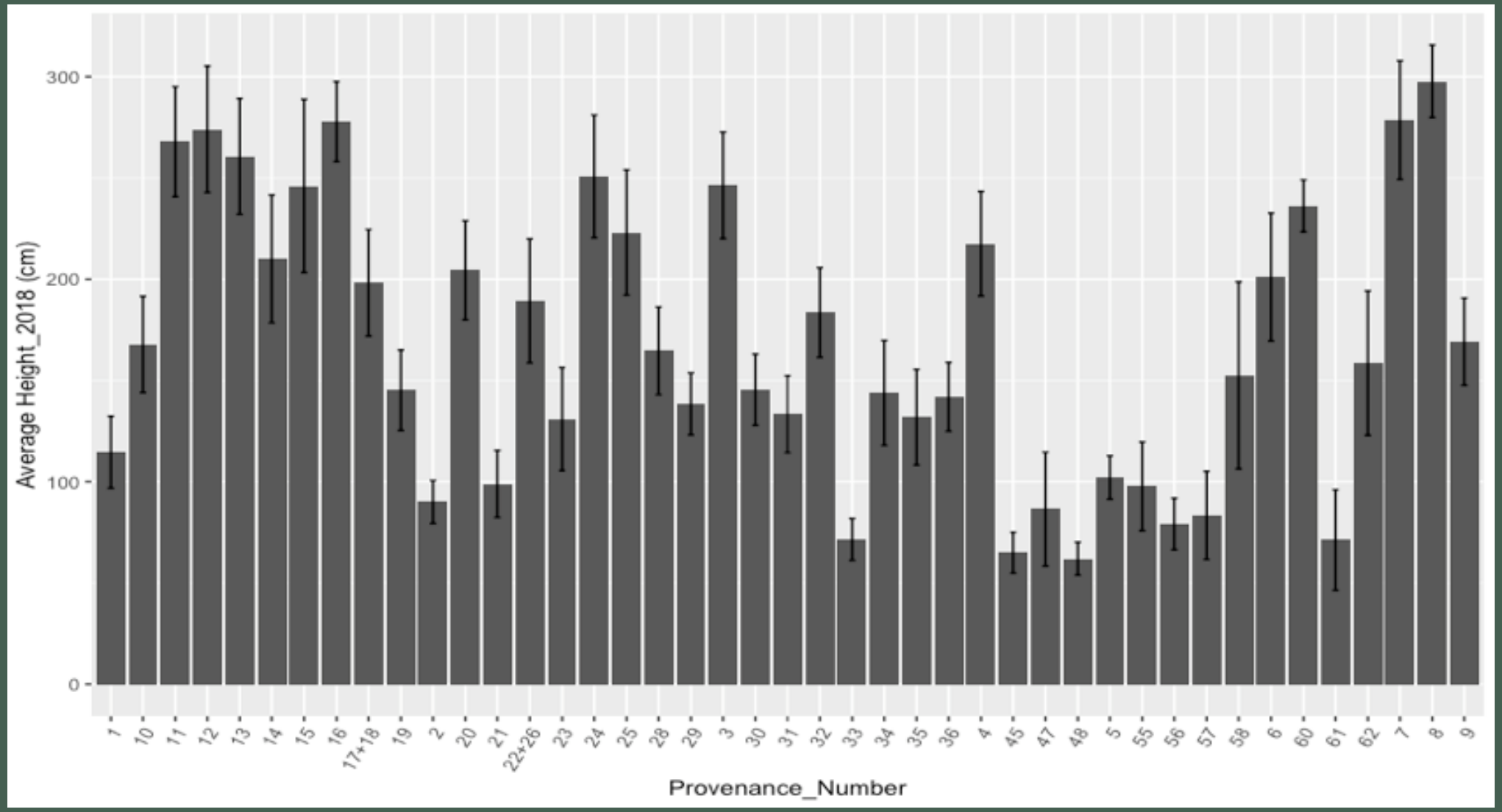
Preliminary Results

Figure 6: Comparison of Provenance Survival Within Mosfell Peatland



Preliminary Results

Figure 7: Comparison of Provenance Height Growth Within Mosfell Peatland



Preliminary Results

Table 11: Top 5 Provenances for Survival (Only Mosfell Peatland)

Provenance Number	Name	Species	Survival Rate	Avg. Height
60	Soldotna	SvG	84%	236 cm
16*	Summit Lake	SB	81%	279 cm
32	Taraldsoy	SG	73%	184 cm
8*	Kenai City	HG	70%	298 cm
29	Yakutat	SG	69%	138 cm

Preliminary Results

Table 12: Top 5 Provenances for Height Growth (Only Mosfell Peatland)

Provenance Number	Name	Species	Avg. Height	Survival Rate
8*	Kenai City	HG	298 cm	70%
7	Ninilchik	SB/HG	279 cm	45%
16*	Summit Lake	SB	279 cm	81%
12	Cooper Lake	SB/SG	274 cm	35%
11	Kenai Lake	SB	268 cm	38%

Preliminary Results

- Comparison of Top 5 Provenances for Survival and Height Growth for Holtsdalur95 and Mosfell Peatland Combined and Individually
  - Survival – #32 (Taraldsoy, SG)
    #29 (Yakutat, SG)
    #10 (Nash Rd., SG)
  - Height – #21 (Icy Bay, SG) and #28 (Dyea, SG)
  - Survival & Height – #32 (Taraldsoy, SG)
    #28 (Dyea, SG)
    #10 (Nash Rd., SG)

Preliminary Results

- Combined Analysis of Mosfell Peatland, Sandlaekjarmyri, Laekur, Hofdi
  - Examined common provenances

Table 13: Overall Survival Rate and Average Height Growth

Site	Alive	Dead	Survival Rate	Avg. Height
Mosfell Peatland	863	1037	45%	197 cm
Sandlaekjarmyri	694	826	46%	370 cm
Laekur	501	829	38%	257 cm
Hofdi	1034	486	68%	269 cm

Preliminary Results

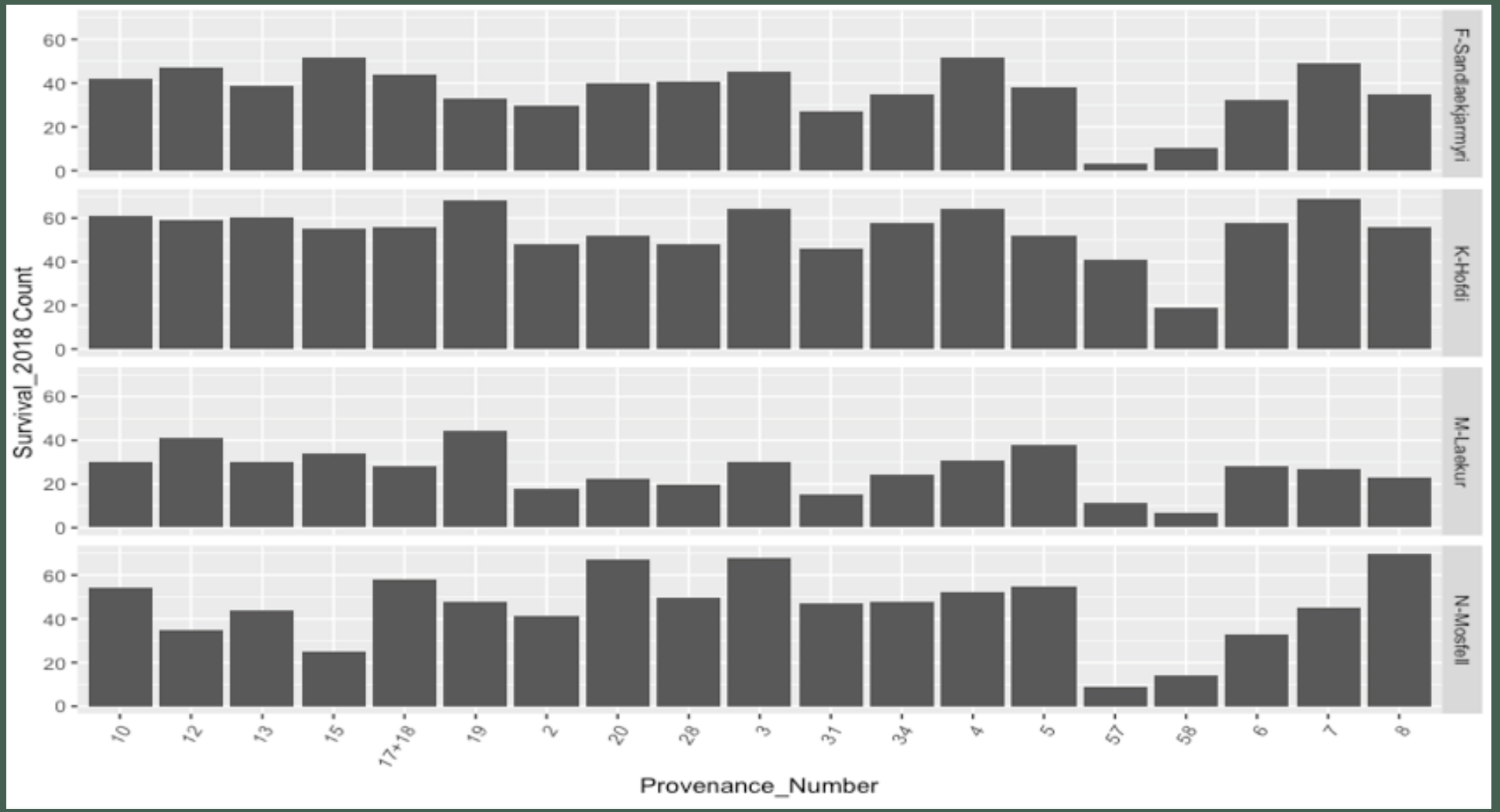
- **Statistical Analysis (combined Mosfell Peatland, Sandlaekjarmyri, Laekur, Hofdi)**

Table 14: P-Values for the Correlations of Survival and Height Growth with Multiple Factors

Factor	Correlation with Survival	Correlation with Height Growth
Site	<0,001	<0,001
Provenance	<0,001	<0,001
Site * Provenance	<0,001	<0,001

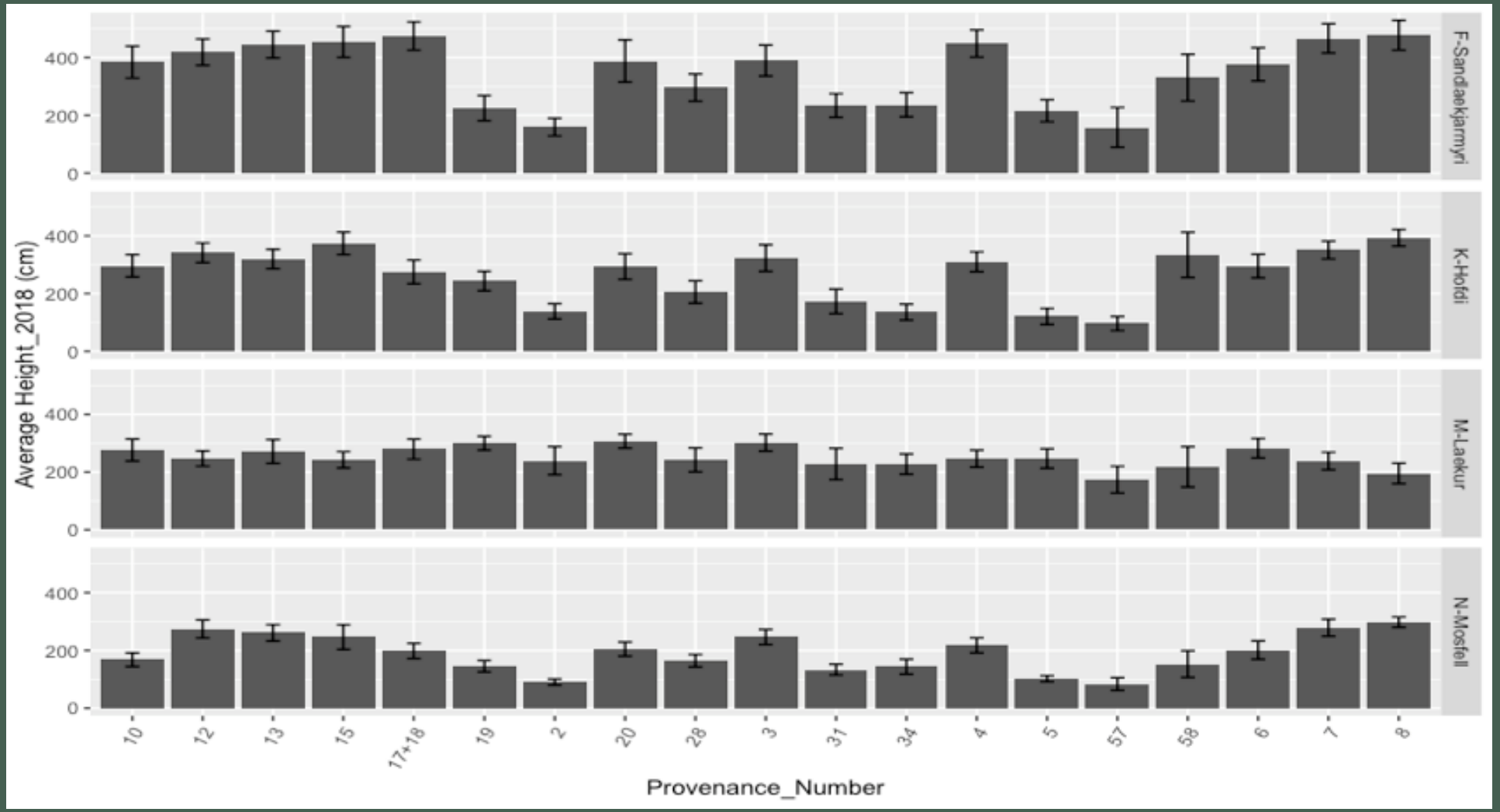
Preliminary Results

Figure 8: Comparison of Provenance Survival Between Mosfell Peatland, Sandlaekjarmyri, Laekur, Hofdi



Preliminary Results

Figure 9: Comparison of Provenance Height Growth Between Mosfell Peatland, Sandlaekjarmyri, Laekur, Hofdi



Preliminary Results

Table 15: Top 5 Provenances for Survival
(Combined Mosfell Peatland, Sandlaekjarmyri, Laekur, Hofdi)

Provenance Number	Name	Species	Survival Rate	Avg. Height
3	Iniskin Bay	SG/SB	63%	309 cm
4	Chinita Bay	SG/SB	60%	312 cm
19	Valdez	SG	58%	229 cm
7*	Ninilchik	SB/HG	58%	348 cm
10	Nash Rd.	SG	57%	276 cm

Preliminary Results

Table 16: Top 5 Provenances for Height Growth
(Combined Mosfell Peatland, Sandlaekjarmyri, Laekur, Hofdi)

Provenance Number	Name	Species	Avg. Height	Survival Rate
15	Hope Rd.	SB	353 cm	50%
7*	Ninilchik	SB/HG	348 cm	58%
8	Kenai City	HG	348 cm	56%
12	Cooper Lake	SB/SG	327 cm	55%
13	Moose Pass	SB/SG	325 cm	52%

Preliminary Results

- Comparison of Top 5 Provenances for Survival and Height Growth for Frost Prone Sites Combined and Individually (5 Datasets Total)
  - Survival – #4 (Chinita Bay, SG/SB)
    #7 (Ninilchik, SB/HG)
    #3 (Iniskin Bay, SG/SB)
    #19 (Valdez, SG)
  - Height – #7 (Ninilchik, SB/HG)
    #8 (Kenai, HG)
    #15 (Hope Rd., SB)
    #12 (Cooper Lake, SB/SG)
  - Survival & Height
    #7 (Ninilchik, SB/HG)
    #8 (Kenai, HG)
    #15 (Hope Rd., SB)
    #12 (Cooper Lake, SB/SG)

Summary of Preliminary Results

- Sheltered field sites – protection from wind, salt, and frost damage
  - Sitka spruce is the best option for afforestation for efficiency and effectiveness
  - Provenance #32 (Taraldsoy), #28 (Dyea), and #10 (Nash Rd.) are the strongest candidates

- Frost prone areas, however, have better success with SB as a hybrid itself or as part of a hybrid with a third species
  - Provenance #7 (Ninilchik, SB/HG) is the strongest candidate
  - Provenance #3 (Iniskin Bay, SG/SB)
  - Provenance #4 (Chinita Bay, SG/SB)

  } – good survival rates; okay heights

  - Provenance #8 (Kenai City, HG) – good height; okay survival rate

Next Steps

- Refine and Confirm Statistics
- Look Closer at Site*Provenance Interaction
- Block Consideration
  - Seems to only sometimes have significant correlation with survival and height growth
  - Local conditions within sites might have an influence
    - Edge effect, gradient of topography, microclimate, etc.

Significance

- Environmental advantages & disadvantages
- Viable timber industry
- Knowledge for climate change

(M. Duong, 2018)

Citations

Farr, W.A. & Harris, A.S. (1979). Site Index of Sitka Spruce Along the Pacific Coast Related to Latitude and Temperatures. *Forest Science*, 25(1), 145-153.

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