Appendix 2. Summary of climate stressors and potential impacts to subsistence harvest

Table A2.1 Description of climate stressors, and potential impacts to harvesting subsistence resources as reported by harvesters.

Physical Stressor	Kotzebue and Kivalina Harvesters Description	Quantitative trend	Harvester perception	Impact on access
Sea ice	Extent, thickness, duration of sea ice reduced	Declining sea ice extent and thickness in Kotzebue Sound; Chukchi Sea (Mahoney et al. 2014; Farquharson et al. 2018,	Agree	Harder and more dangerous to access animals that use the sea edge, short window of time to hunt ice-dependent species, people dying in unsafe ice conditions.
Weather	Changes in rain, snow, wind outside of 'normal' weather patterns for the region	Increased air and sea temperature in Kivalina and Kotzebue (NOAA Climate Data Online Database)	Agree	Harder to travel on snow machine in low snow cover, unpleasant to travel/hunt in wet/windy conditions, harder to process (dry fish and meat) in rainy conditions, wind can move broken ice and make for difficult boating conditions, animals harder to hunt in wind.
Coastal erosion	Erosion (loss of habitat) of coastal shorelines	Accreting and erosion spots in Kivalina and Kotzebue (Gibbs et al. 2019; Fang et al. 2019)	Agree with erosion areas, accretion areas not discussed	Harder to travel around places where beach has eroded, people losing allotment land or physical structures.
Snow cover	Decreased snow cover	Earlier end to the continuous snow pack in Cape Krusenstern National Monument (Euskirchen et al. 2016; Swanson 2017)	Agree, although specific details of snow thickness or snow cover end dates not detailed	Harder to travel by snow machine, snow machine trails not in good condition, rain on snow events dangerous for caribou.
High water	Flooding of coastal areas, happens in certain storm and wind conditions.	Increased flooding and erosion in Kivalina (Fang et al. 2019); data unavailable for Kotzebue	Agree (Kivalina; data not available for Kotzebue)	Increased coastal erosion makes areas more difficult to access.
Permafrost degradation	Melting of frozen permafrost that causes uneven ground, erosion, etc.	Increased ground temperatures in Northwest Alaska (Batir et al. 2017)	Agree	Harder to use ATVs or snow machine on melted permafrost, increases sinkholes and erosion of access trails.

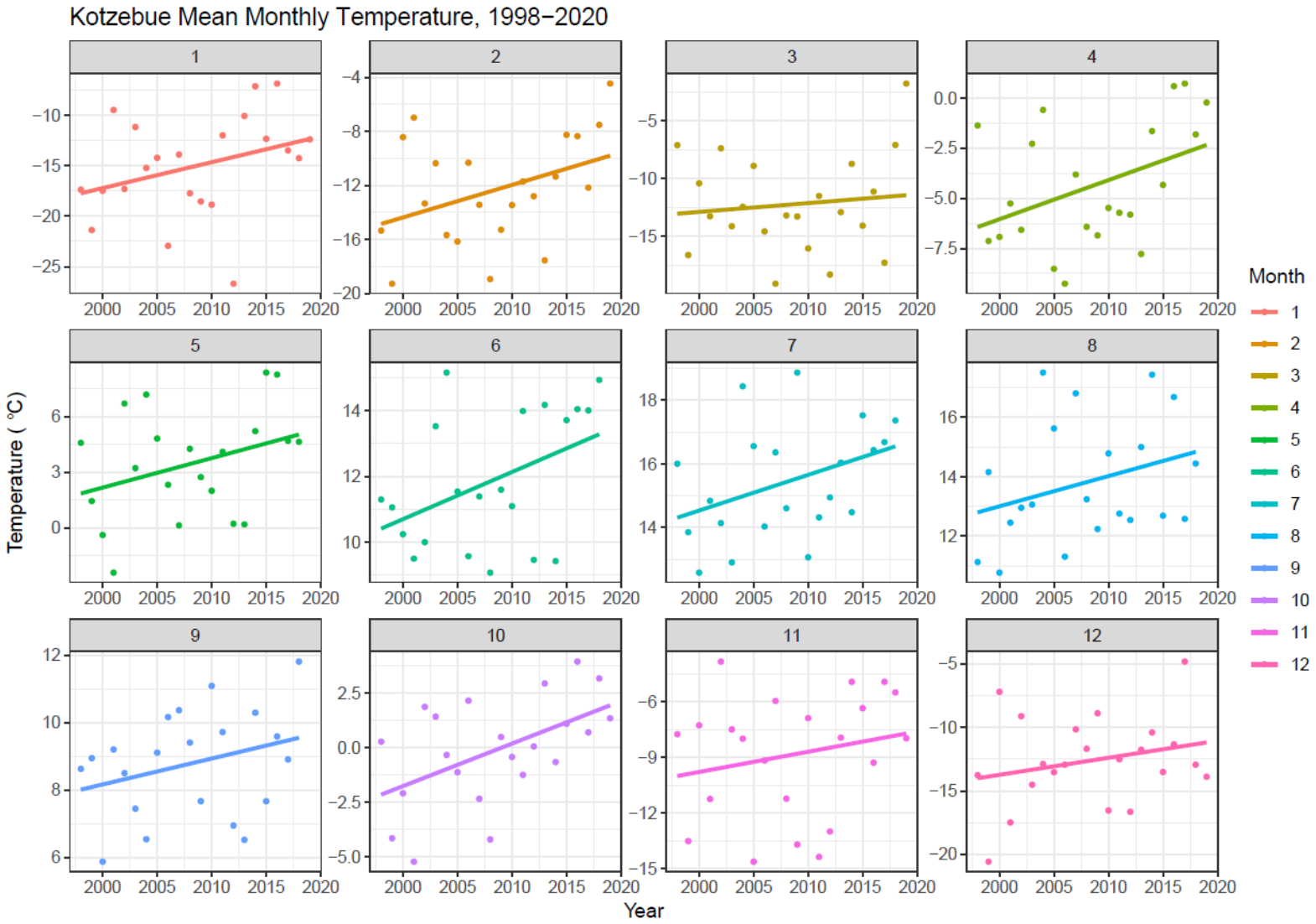

Figure A2.1 Trends in air temperature in Kotzebue, Alaska, from 1998 to 2020. Points are the average of daily temperature values for each month. Lines are predicted values from linear regression models fitted to the data (see Table A2.2). Data source: NOAA National Center for Environmental Information.

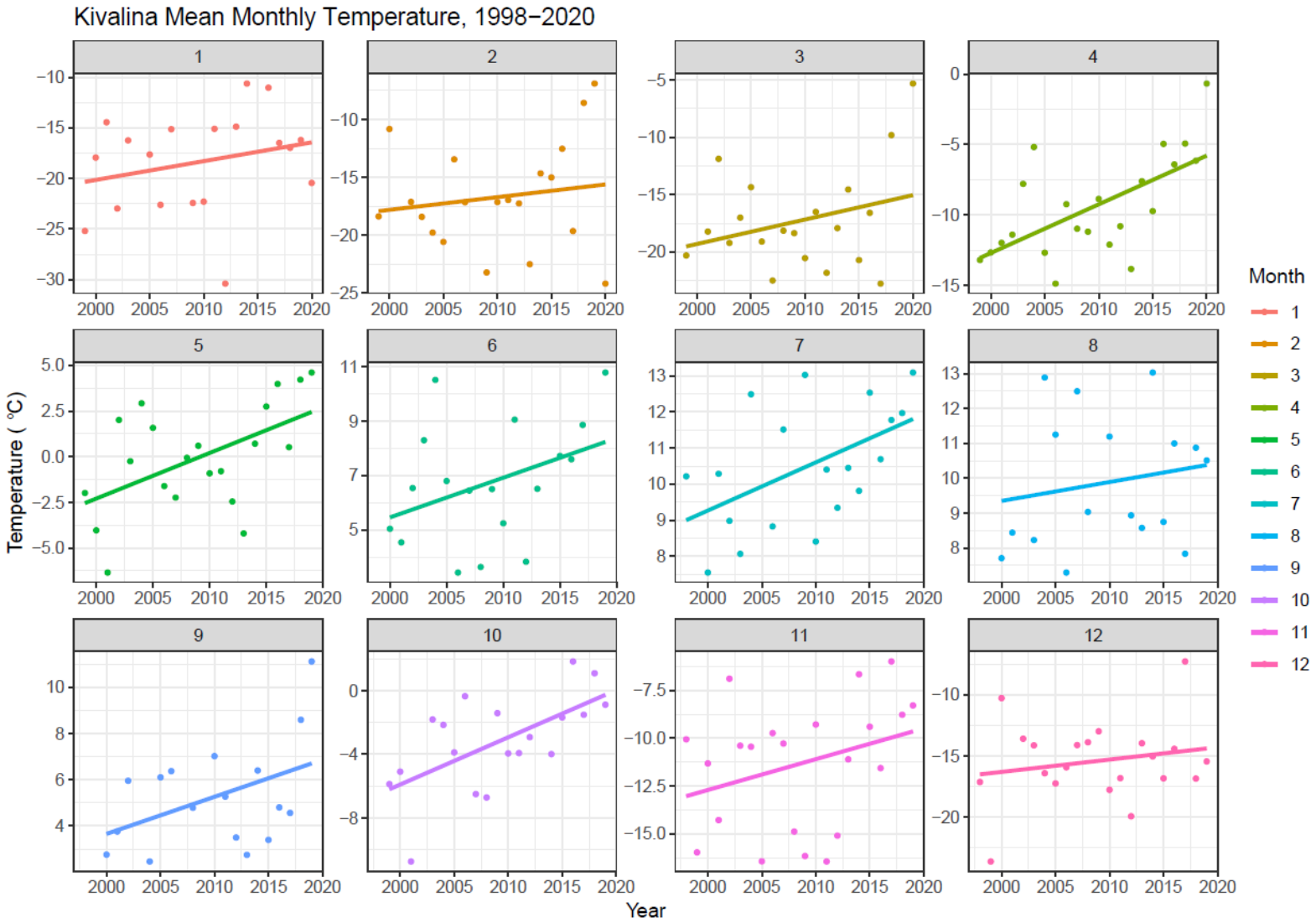

Figure A2.2 Trends in air temperature in Kivalina, Alaska, from 1998 to 2020. Points are the average of daily temperature values for each month. Lines are predicted values from linear regression models fitted to the data (see Table A2.2). Data source: NOAA National Center for Environmental Information.

Table A2.2 Estimated slope coefficients, F statistics, p-values, and R^2 values for fitted linear regression models of monthly mean air temperature versus year for Kotzebue and Kivalina. Significant regression fits ($p < 0.1$) are marked with an asterisk.

Location	Month	Estimated slope coefficient	F statistic	p-value	R^2
Kotzebue	January	0.183	1.429	0.245	0.064
Kotzebue	February	0.108	0.606	0.445	0.028
Kotzebue	March	0.080	0.370	0.549	0.017
Kotzebue	April	0.184	4.382	0.049*	0.173
Kotzebue	May	0.184	3.952	0.061*	0.165
Kotzebue	June	0.143	4.411	0.049*	0.188
Kotzebue	July	0.112	3.383	0.082*	0.151
Kotzebue	August	0.102	1.987	0.175	0.095
Kotzebue	September	0.077	1.913	0.183	0.091
Kotzebue	October	0.195	7.471	0.013*	0.272
Kotzebue	November	0.109	0.954	0.340	0.046
Kotzebue	December	0.134	1.318	0.264	0.062
Kivalina	January	0.186	1.158	0.297	0.064
Kivalina	February	0.110	0.443	0.514	0.024
Kivalina	March	0.213	1.732	0.205	0.088
Kivalina	April	0.346	12.860	0.002*	0.391
Kivalina	May	0.250	7.358	0.014*	0.279
Kivalina	June	0.146	2.677	0.121	0.143
Kivalina	July	0.134	6.109	0.024*	0.264
Kivalina	August	0.054	0.481	0.499	0.031
Kivalina	September	0.160	3.539	0.079*	0.191
Kivalina	October	0.297	10.580	0.005*	0.384
Kivalina	November	0.161	2.185	0.155	0.098
Kivalina	December	0.101	0.762	0.394	0.039

Literature Cited

Batir, J. F., M. J. Hornbach, and D. D. Blackwell. 2017. Ten years of measurements and modeling of soil temperature changes and their effects on permafrost in Northwestern Alaska. *Global and Planetary Change* 148:55-71.

Euskirchen, E. S., A. P. Bennett, A. L. Breen, H. Genet, M. A. Lindgren, T. A. Kurkowski, A. D. McGuire, and T. S. Rupp. 2016. Consequences of changes in vegetation and snow cover for climate feedbacks in Alaska and northwest Canada. *Environmental Research Letters* 11(10): p.105003.

Fang, Z., P. T. Freeman, C. B. Field, and K. J. Mach. 2018. Reduced sea ice protection period increases storm exposure in Kivalina, Alaska. *Arctic Science* 4(4):525-537.

Farquharson, L. M., D. H. Mann, D. K. Swanson, B. M. Jones, R. M. Buzard, and J. W. Jordan. 2018. Temporal and spatial variability in coastline response to declining sea-ice in northwest Alaska. *Marine Geology* 404:71-83.

Gibbs, A. E., A. G. Snyder, and B. M. Richmond. 2019. National assessment of shoreline change—Historical shoreline change along the north coast of Alaska, Icy Cape to Cape Prince of Wales: U.S. Geological Survey Open-File Report 2019–1146, 52 p., https://doi.org/10.3133/ofr20191146.

Mahoney, A. R., H. Eicken, A. G. Gaylord, and R. Gens. 2014. Landfast sea ice extent in the Chukchi and Beaufort Seas: The annual cycle and decadal variability. *Cold Regions Science and Technology* 103:41-56.

NOAA National Center for Environmental Information Climate Data Online database [online] URL: https://www.ncdc.noaa.gov/cdo-web/

Swanson, D. K., 2017. Trends in greenness and snow cover in Alaska's Arctic National Parks, 2000–2016. *Remote Sensing* 9(6):514.