Science, Service, Stewardship

Using indicators to assess vulnerability and resiliency in Alaskan communities

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Key Points of Presentation

- This approach can ***integrate*** a lot of data sources without having to explicitly weight them
- One can estimate ***community vulnerability*** to different sources of risk/impacts both individually and collectively
- Identifies factors (principal components) that explain ***variability in community characteristics***
- Creates an ***index*** to rank vulnerability of communities to sources of change
- Being ***applied nationally*** by NOAA social scientists

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Overview

- Context of fishing communities in Alaska
- Socio-economic indices of community vulnerability
- Data/methods
- Physical vulnerability (to climate change) index
- Fisheries vulnerability index
- Socio-economic vulnerability index
- Discussion questions


Beaufort Sea
Chuckchi Sea
Kotzebue Sound
Norton Sound
Bering Sea
Cook Inlet
Prince William Sound
Gulf of Alaska

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Social indicators of vulnerability

- ***Vulnerability*** is the susceptibility of a community to exposure from a hazard event or other disturbance and their capacity for response.
- ***Resilience*** refers to the adaptive capacity of a community to cope successfully with change and adapt in the face of specific disturbances.
- Recent papers on social vulnerability and environmental /management impacts
  - Cutter et al. (2003,2008), Jacob and Jepson (2007) , Jacob et al (2010) , Colburn (2013)
- Effort within NOAA to create nationwide database of social indicators
  - Applicability: Fisheries management program performance (e.g., catch shares), predicting social impacts of proposed management programs, vulnerability to climate change

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Vulnerability to Climate Change

- Exposure to the physical effects of climate change
  - Physical vulnerability index
- Dependence on resources that will likely be affected by climate change
  - Fisheries vulnerability index
- Adaptive Capacity/Resilience to offset potential impacts
  - Socio-economic/demographic vulnerability index

Projected climate change impacts in Alaska

- Uncertain how seasonal conditions will change
- Ice farther from shore, thinner, present for less time
  - Lack of ice affects hunting; travel farther and longer; increases personal risk and fuel costs
- Melting permafrost – increases erosion and soil instability
- Coastal erosion/inundation – directly impacts infrastructure
- Increased vulnerability to storm surge and rough seas
  - Hunting/fishing more difficult, threaten life in coastal communities
- Changes in distribution and abundance of fish
- Displacement of subsistence resources
  - Intensifying threats to subsistence livelihoods
  - Potential food security issues when resources are scarce

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Data

- Physical data
  - Government reports (GAO, State of AK, FEMA)
  - Universities (permafrost)
  - Sea ice and sea surface temperature (NOAA Climate Data Center)
- Fisheries data
  - Commercial landings, permits, revenue, vessels, processors, quota share allocation (NMFS, ADFG)
  - Recreational licenses, guides, charter businesses (NMFS, ADFG)
  - Subsistence permits, halibut and salmon catch, marine mammal take (ADFG, USFWS, Alaska Beluga Whale Commission)
- Socioeconomic Data
  - American Community Survey 2005-2009 (Census Bureau)
  - 2000 and 2010 decennial census (Census Bureau)
  - Alaska Local and Regional Information (ALARI) database

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Methods

- Principal Components Analysis
  - Varimax Rotation
  - Kaiser Normalization
  - Using the Kaiser Criterion (keep only Eigenvalues >1)
  - Results normalized into z-scores
- Three main indices of vulnerability
  - Socio-economic vulnerability/resilience index
  - Fisheries vulnerability index
  - Climate change vulnerability index
- Group the least vulnerable 20% (yellow), middle 60% (orange) and most vulnerable 20% (red) communities by index scores

Exposure to Climate Change

Physical vulnerability index

Physical Vulnerability Index

Component	Eigenvalue	% variation explained
Permafrost type/latitude	2.78	19.8%
Erosion risk	2.72	19.4%
High Ice coverage	2.05	14.7%
Mean ice coverage	1.10	7.8%
Distance to next permafrost zone	1.08	7.7%
100% ice coverage	1.08	7.7%
	Total	77.2%

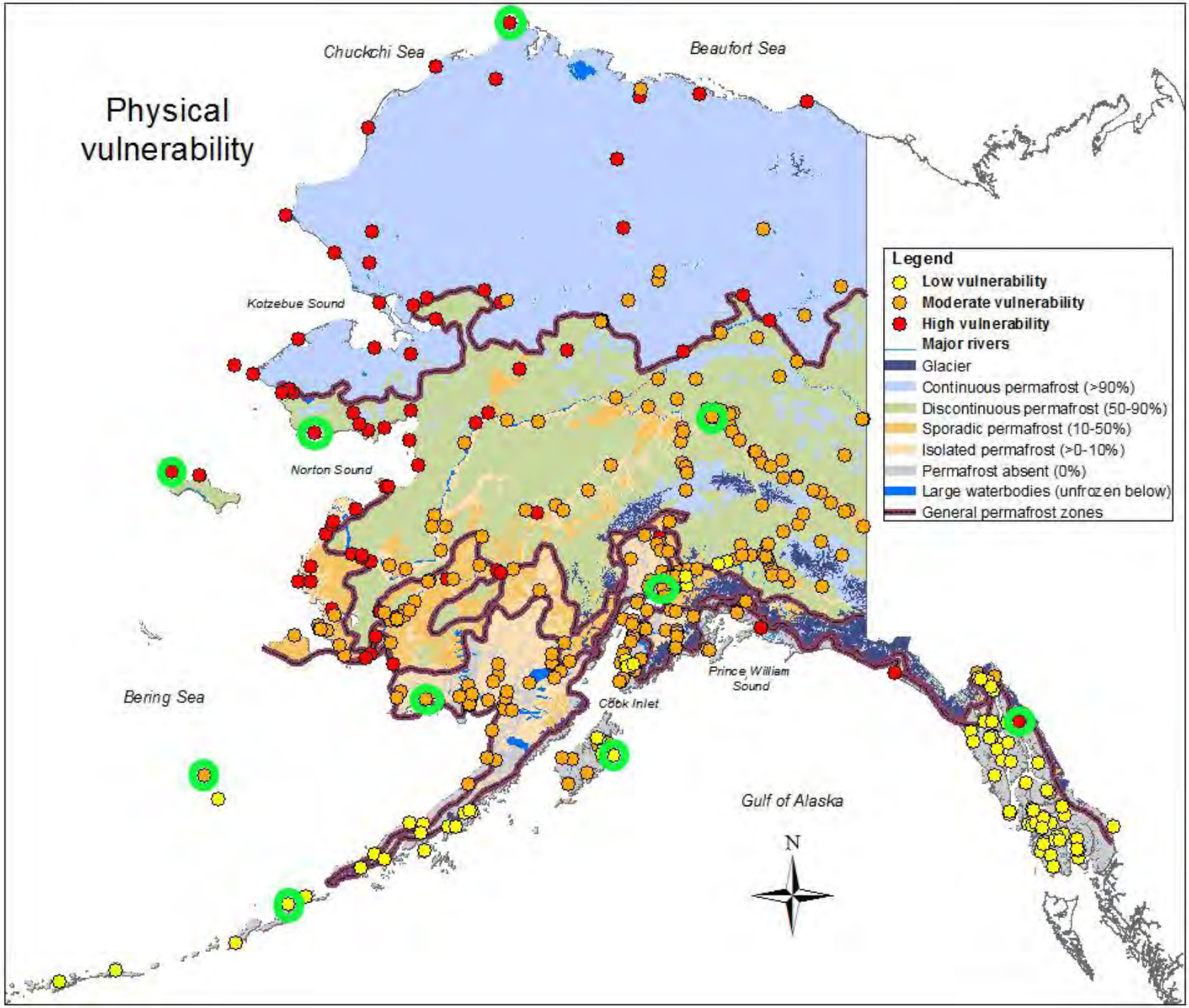
Variables

Erosion: State of AK, GAO or Army Corps identified as threatened, relocation plan in place, FEMA mitigation plan in place, elevation

Permafrost: permafrost zone, permafrost distance, latitude

Sea Ice Coverage: mean ice, max ice, 100% ice, 75% ice, 0% ice

Community	Index	Rank
Anchorage	-0.85	427
Barrow	5.51	13
Fairbanks	-0.02	310
Gambell	1.03	63
Juneau	0.65	68
Kodiak	-1.60	522
Nome	18.07	1
St. Paul	0.49	80
Togiak	-0.29	341
Unalaska	-1.97	559


Physical vulnerability
Chuckchi Sea
Beaufort Sea
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Norton Sound
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Cook Inlet
Prince William Sound
Gulf of Alaska
N
Legend
Low vulnerability
Moderate vulnerability
High vulnerability
Major rivers
Glacier
Continuous permafrost (>90%)
Discontinuous permafrost (50-90%)
Sporadic permafrost (10-50%)
Isolated permafrost (>0-10%)
Permafrost absent (0%)
Large waterbodies (unfrozen below)
General permafrost zones

Resource Dependence

Fisheries vulnerability index

Fisheries Index

Component	Eigenvalue	% variation explained
Commercial participation and subsistence halibut	6.23	15.9%
Sport fishing and subsistence salmon	5.39	13.8%
Commercial participation per capita	4.65	11.9%
Landings and processors per capita	3.02	7.8%
Sport fishing per capita	2.60	6.7%
Commercial landings	2.19	5.6%
Marine mammal pounds	1.93	5.0%
Subsistence salmon per capita	1.91	4.9%
Marine mammal number	1.74	4.4%
Latitude of catch	1.37	3.5%
	Total	79.6%

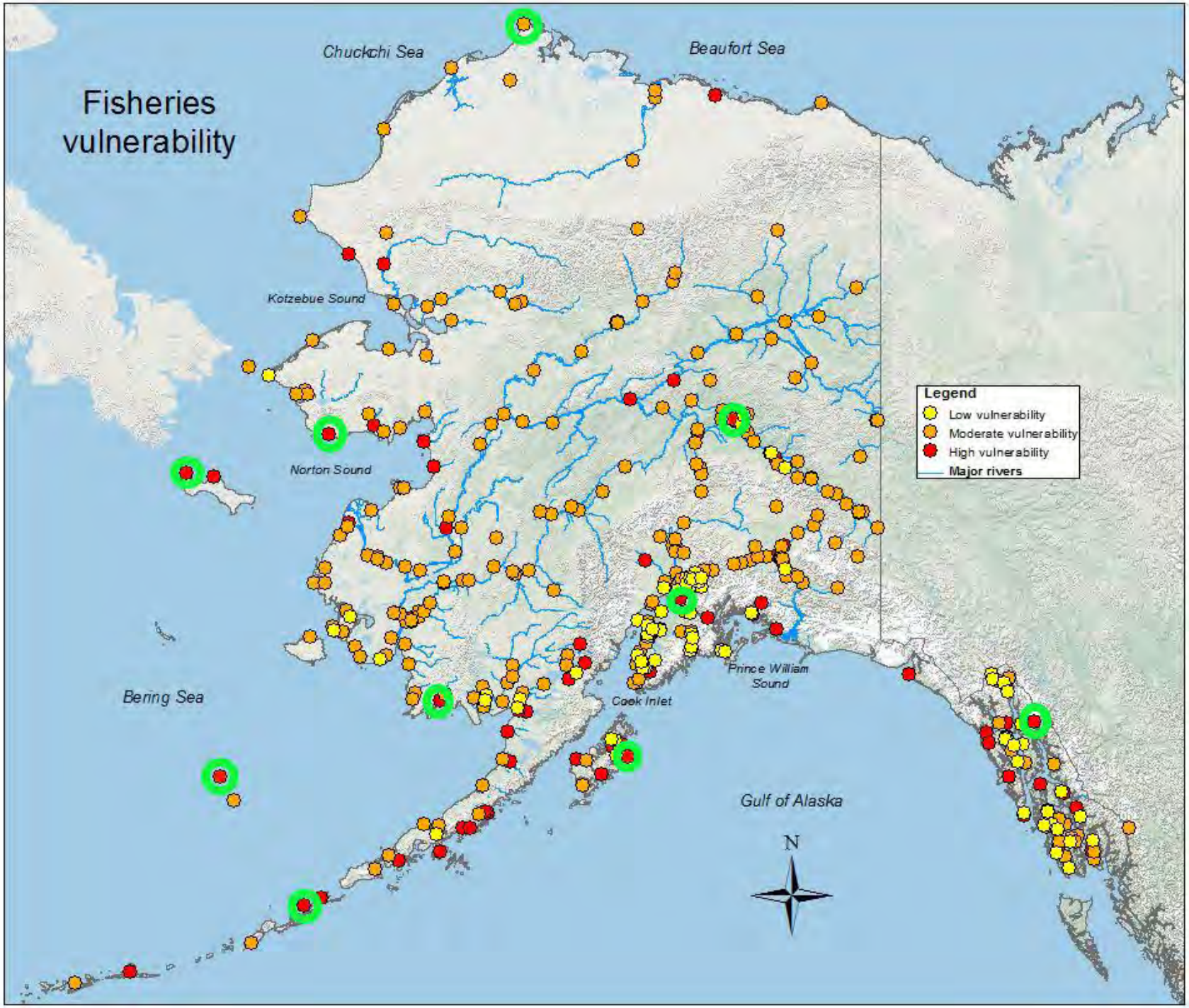
Variables

Commercial: landings, permits, revenue, vessels, processors, quota

Recreational: licenses, guides

Subsistence: permits, halibut and salmon catch, marine mammal take

Community	Index	Rank
Anchorage	13.79	4
Barrow	-0.77	371
Fairbanks	7.61	14
Gambell	7.74	12
Juneau	3.59	39
Kodiak	12.02	6
Nome	3.19	45
St. Paul	1.28	83
Togiak	4.52	30
Unalaska	18.68	1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Adaptive Capacity

Socio-economic vulnerability index

Socio-economic Index

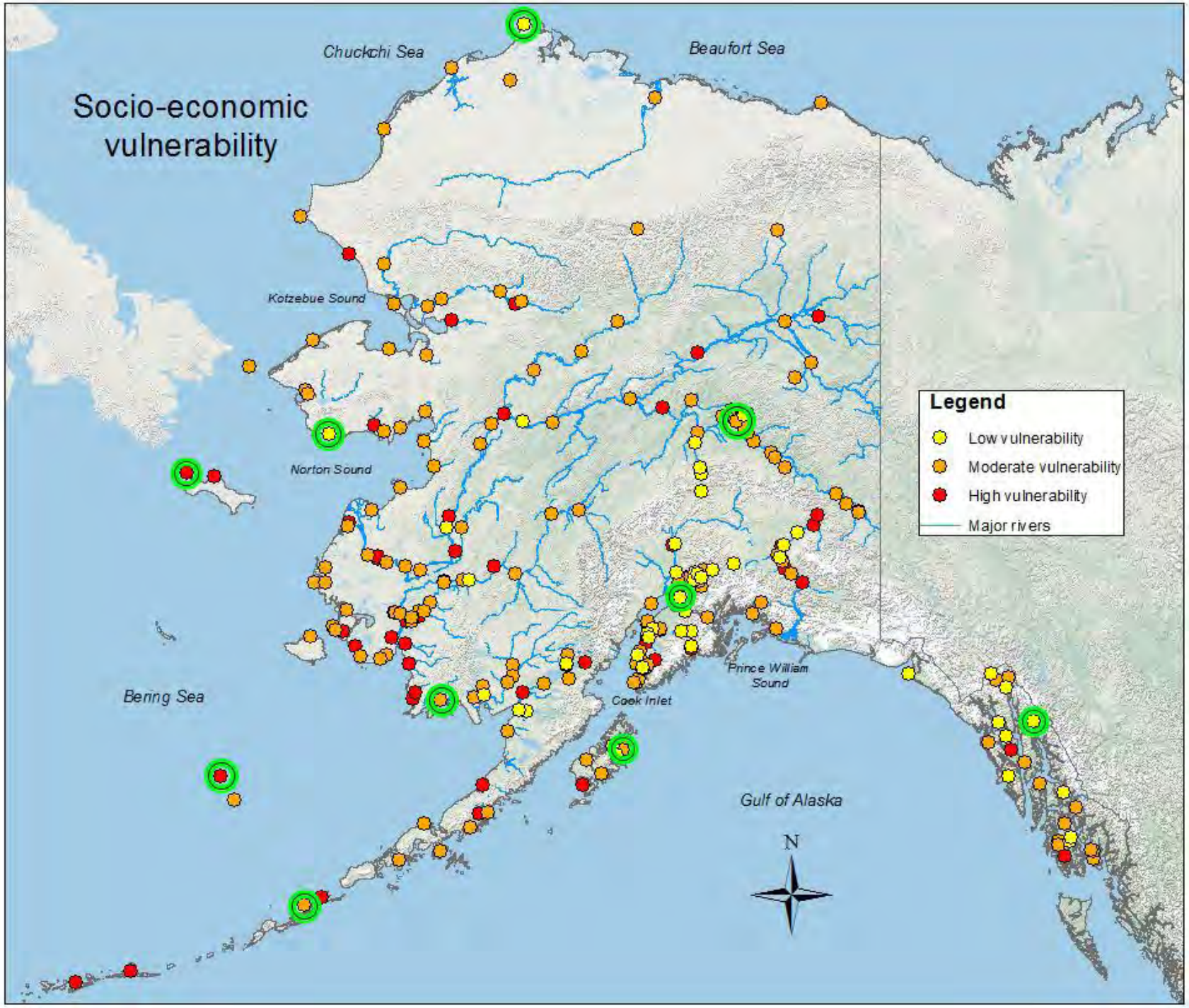
Component	Eigenvalue	% variation explained
Employment diversification	5.07	16.4%
Poverty	5.01	16.2%
Migration	3.47	11.2%
Population composition	2.17	7.0%
Foreigners	2.13	6.9%
Social Security Recipients	1.92	6.2%
Elderly in poverty	1.50	4.9%
	Total	68.6%

Variables

% on social assistance
% in poverty
- % female
- % over 65
- % under 5

% unemployed
% without HS diploma
% Native Alaskan
% female head of household
% speak English less than well
% households with 65+ year olds
% on social security
Employment diversification
- Total
- Female/Male
- Over age 45/Over age 50
- Tax revenue

Community	Index	Rank
Anchorage	-2.48	211
Barrow	-2.46	210
Fairbanks	-1.23	161
Gambell	2.08	49
Juneau	-2.88	225
Kodiak	-0.39	135
Nome	-3.20	231
St. Paul	6.99	6
Togiak	1.54	66
Unalaska	0.08	116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Overall Vulnerability to Climate Change

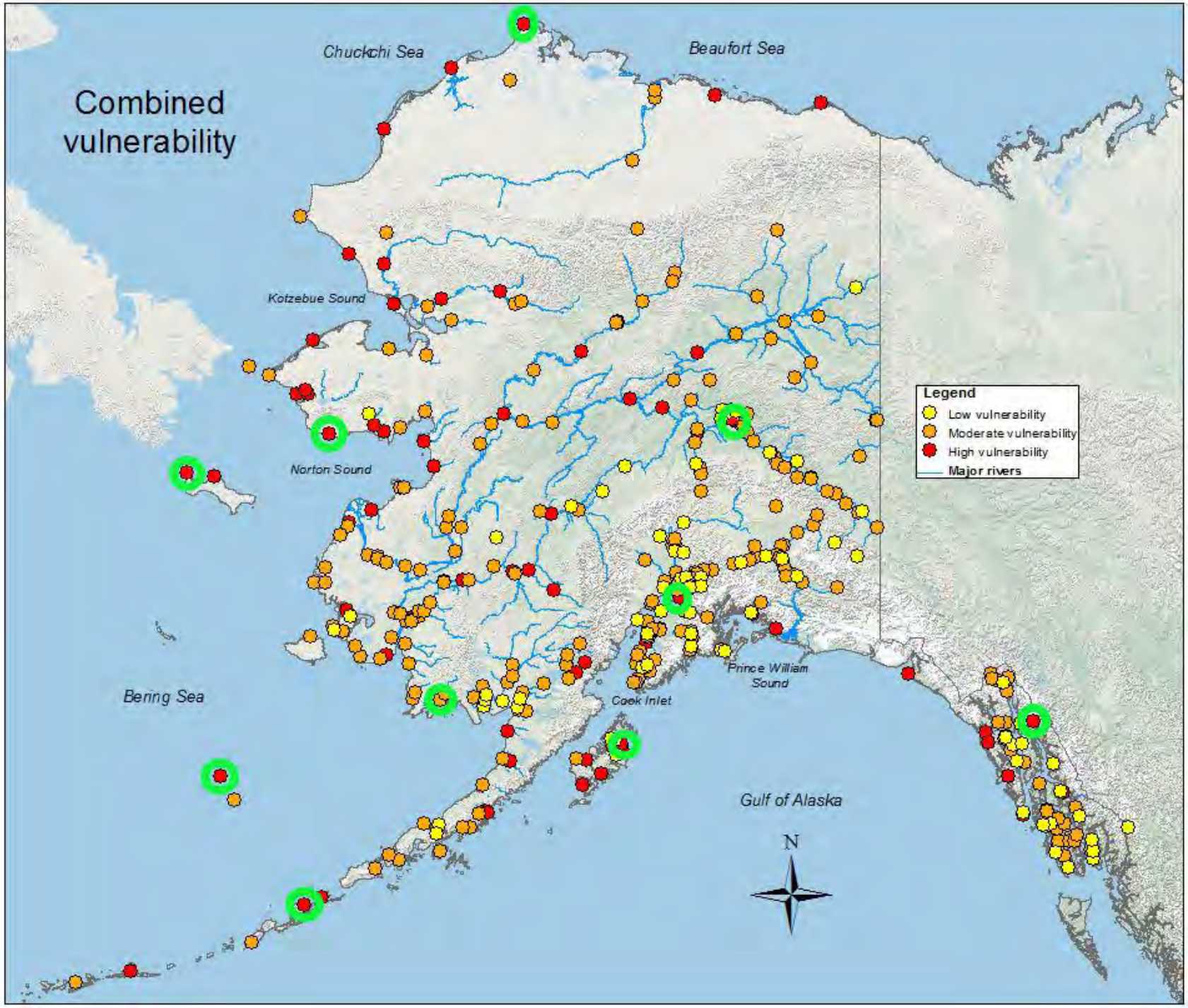
Combined physical risk, fishery dependence, and socio-economic vulnerability to climate change Index

Combined physical risk, fishery dependence, and socio-economic vulnerability to climate change Index

Component	Eigenvalue	% variation explained
Poverty and demographics	6.83	8.13%
Subsistence halibut and commercial participation	6.23	7.41%
Latitude of catch	5.99	7.14%
Sport fishing	5.39	6.42%
Employment diversification	4.97	5.92%
Household stability	3.48	4.14%
Commercial landings per capita	3.13	3.73%
Erosion	2.89	3.44%
High ice coverage	2.21	2.63%
Marine mammal pounds	2.20	2.62%
Distance to permafrost zone	1.18	1.40%
	Total	78.4%

Includes all variables from all previous indices (102 total)

Community	Index	Rank
Anchorage	13.81	5
Barrow	6.72	29
Fairbanks	5.67	41
Gambell	7.91	20
Juneau	3.29	76
Kodiak	11.98	7
Nome	14.93	3
St. Paul	7.75	22
Togiak	1.96	118
Unalaska	11.40	9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Comparison of Index Values

Community	Rank Overall	Rank Physical	Rank Fisheries	Rank SocioEconomic
Anchorage	5	427	4	211
Barrow	29	13	371	210
Fairbanks	41	310	14	161
Gambell	20	63	12	49
Juneau	76	68	39	225
Kodiak	7	522	6	135
Nome	3	1	45	231
St. Paul	22	80	83	6
Togiak	118	341	30	66
Unalaska	9	559	1	116

Discussion questions

- Alaska is a natural resource dependent (oil, fisheries, mining) Arctic/sub-Arctic region.
    - What other threats and/or variables or indices would be important to consider?
    - Sea-level rise? Environmental disasters? Drought? Infectious disease? Other?
- Opening of the northwest passage and arctic drilling could benefit from a a similar analysis of potential risks and benefits associated with these activities for local communities
- These are all relative rankings, so what does it mean to be near the most vulnerable?
    - Are they vulnerable in absolute terms?
- What should communities do if they are defined as vulnerable?
- Contact Amber.Himes@NOAA.GOV with any questions!