Climate Change Planning in Alaska's National Parks

SOUTHEAST ALASKA PARKS

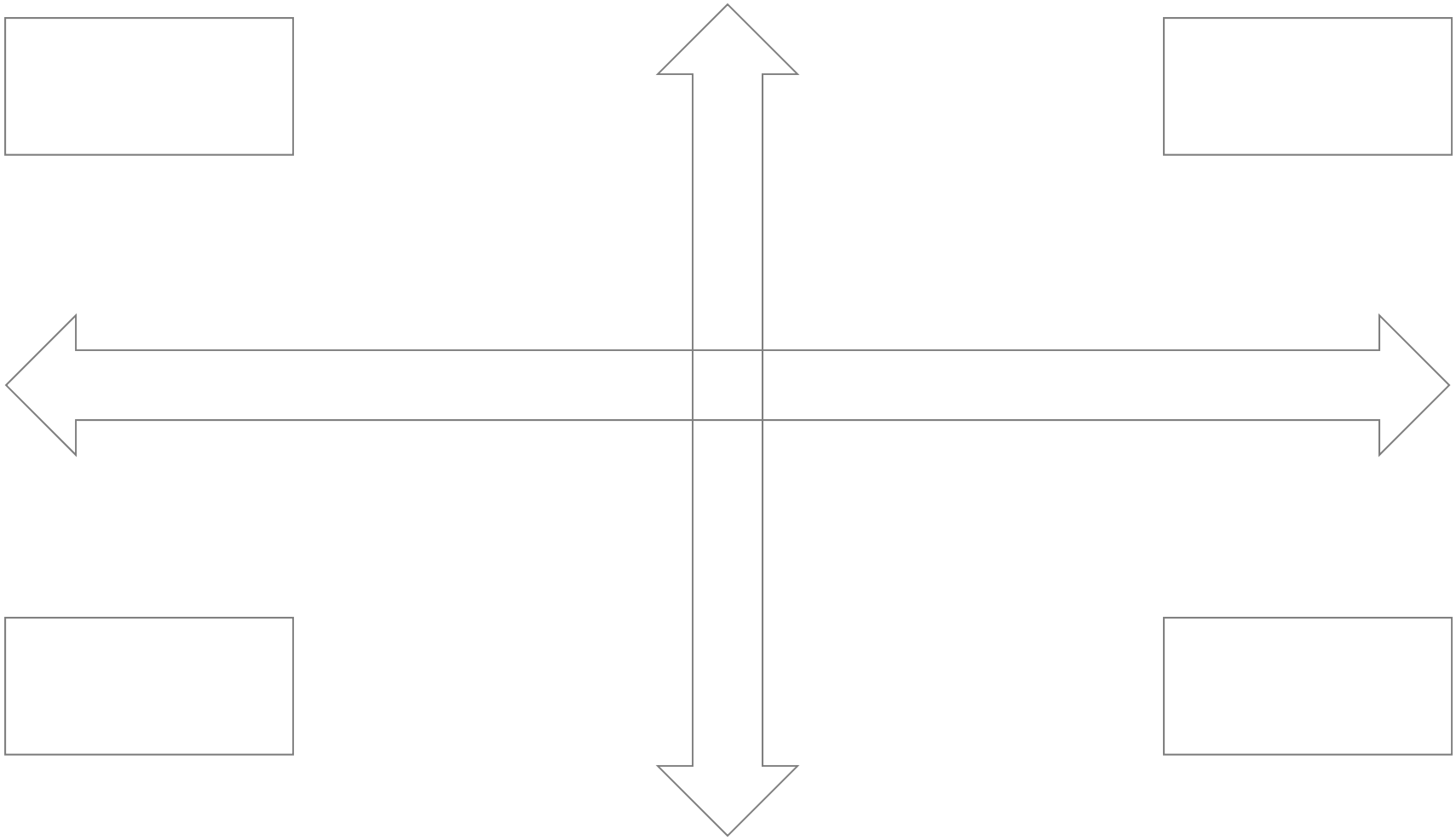
PLENARY #2: SCIENTIFIC BACKGROUND, DRIVERS, AND EFFECTS

Selecting Drivers – Key points

- Drivers are the **Critical forces** in our scenarios planning process.
- Critical forces generally have unusually **high impact** and unusually **high uncertainty**
- We are aiming to create scenarios that are:
  - **Challenging**
  - **Divergent**
  - **Plausible**
  - **Relevant**

CLIMATE SCENARIOS

BIOREGION: _____



CLIMATE SCENARIOS

BIOREGION: _____

Pick drivers with a wide range of possible outcomes

Choose drivers that impact several sectors, e.g tourism, subsistence, and wildlife, not just one

Select drivers with a high enough likelihood to be convincing to stakeholders

Select drivers with effects in most of the parks in the network

Avoid pairs of drivers that are too similar – think of the effects of crossing them with one another

Choose drivers that lead to the effects that are most critical

Climate Change Scenario Drivers

TEMPERATURE AND LINKED VARIABLES

thaw, freeze, season length, extreme days, permafrost, ice, freshwater temperature

PRECIPITATION AND LINKED VARIABLES:

rain, snow, water availability, storms and flooding, humidity

PACIFIC DECADAL OSCILLATION (PDO)

definition, effects, and predictability

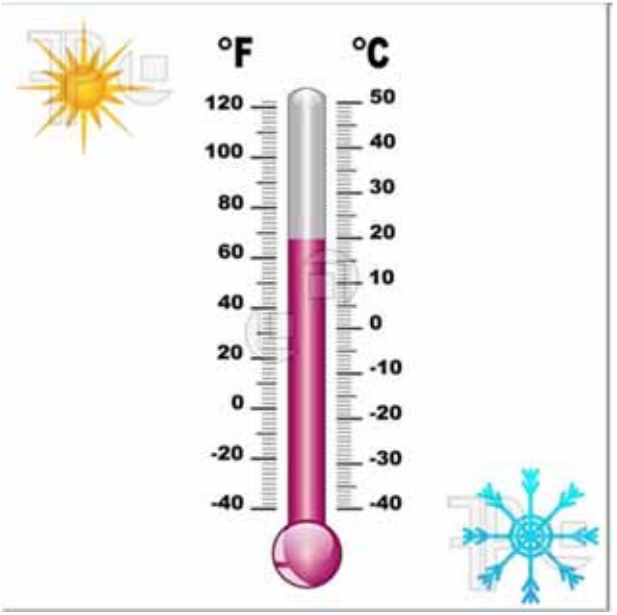
SEA LEVEL

erosion also linked to sea ice and storms

OCEAN ACIDIFICATION

Temperature and linked variables

- Temperature based on downscaled monthly averages from SNAP
  - Uncertainty due to GCM uncertainty, emissions scenarios, downscaling uncertainty, PDO
- Season length, freeze, and thaw dates interpolated from mean monthly temperatures
- Permafrost thaw derived from ground cover, soil type, air temperature projections
- Extreme days an extension of temperature trend
- Sea ice and freshwater temperature also linked to air temperature

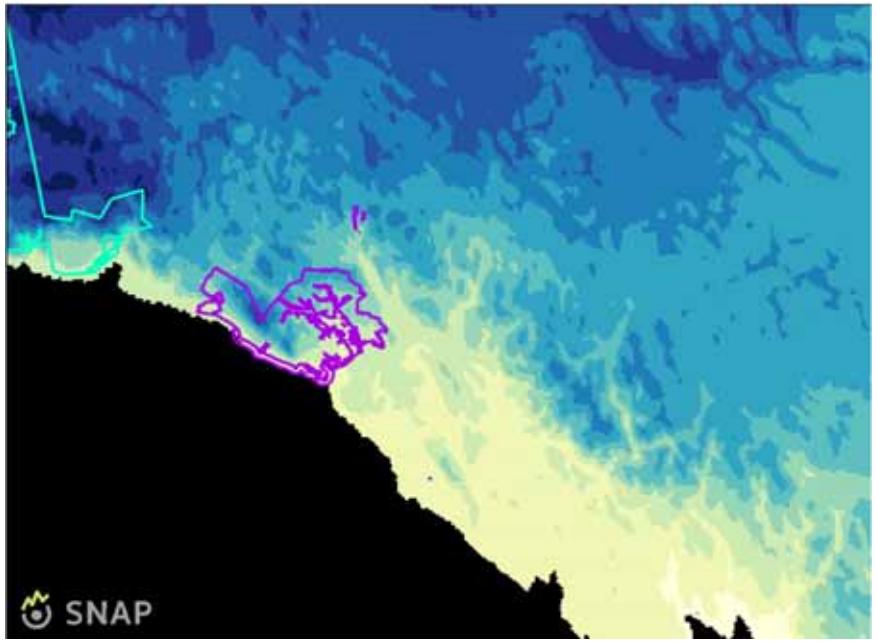


Precipitation and linked variables

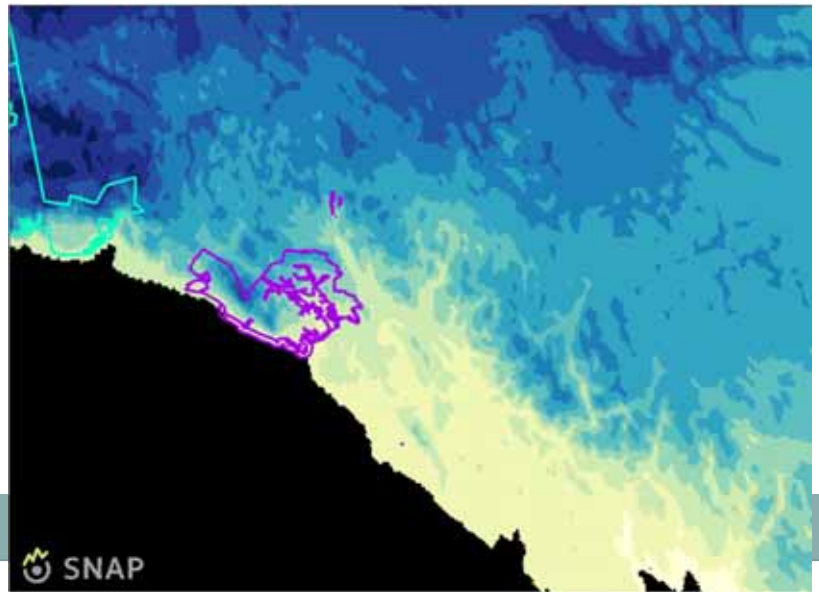
- Temperature based on downscaled monthly averages from SNAP
  - Uncertainty due to GCM uncertainty, emissions scenarios, downscaling uncertainty, PDO
  - Uncertainty greater than for temperature
- Models do not separate rain/snow
- Storms include wind and precipitation
  - Flooding and erosion more dependent on timing than quantity
- Water availability linked to precipitation and temperature
- Humidity and cloud cover

Projected Winter Temperatures

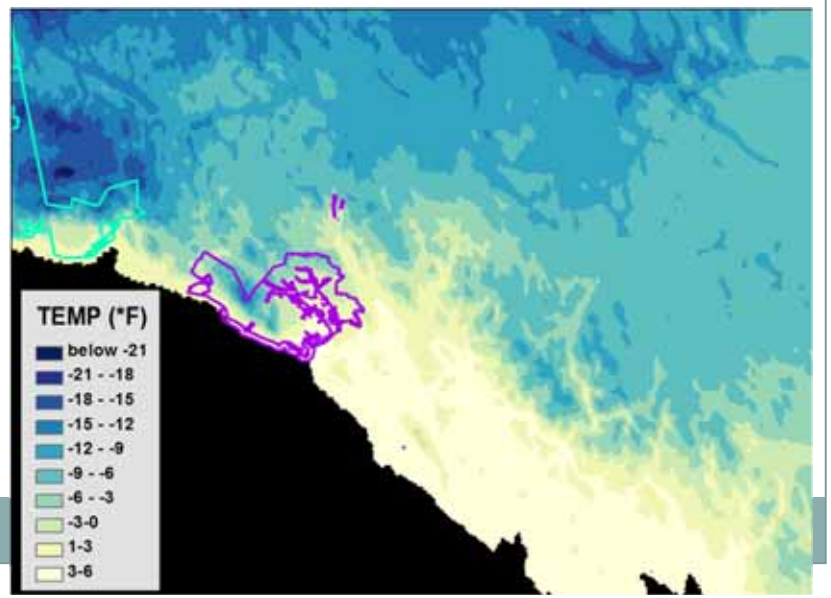
2010's

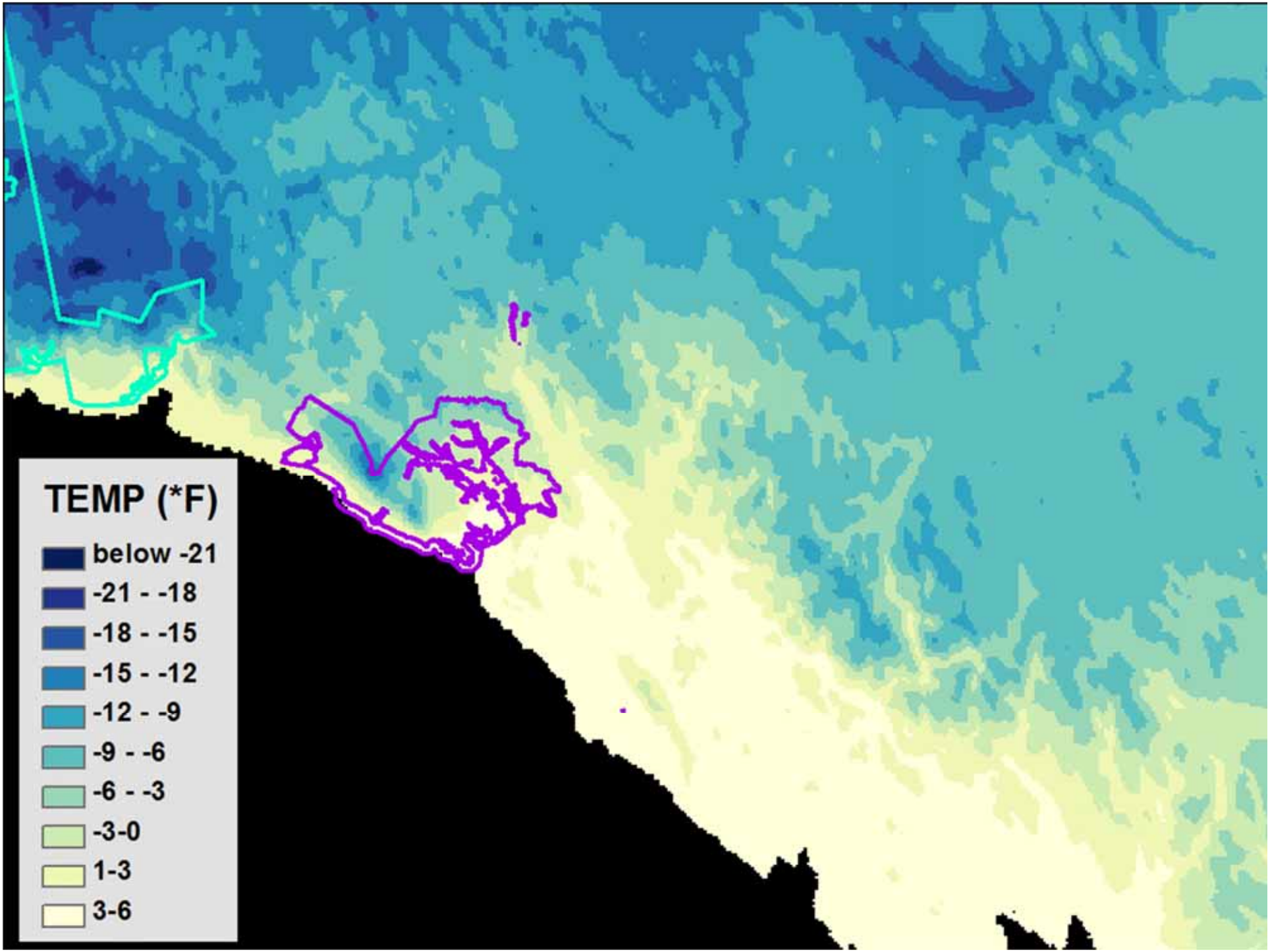


2050's



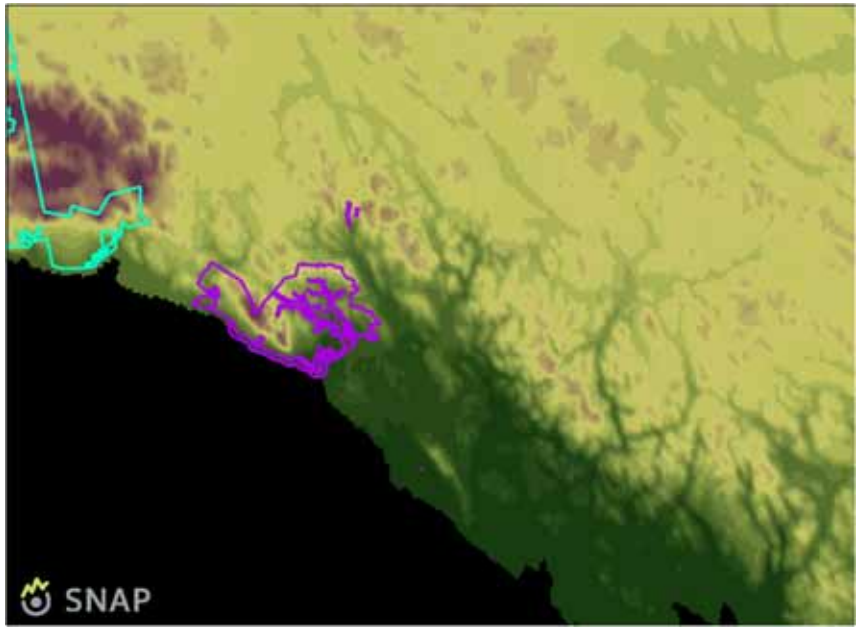
2090's



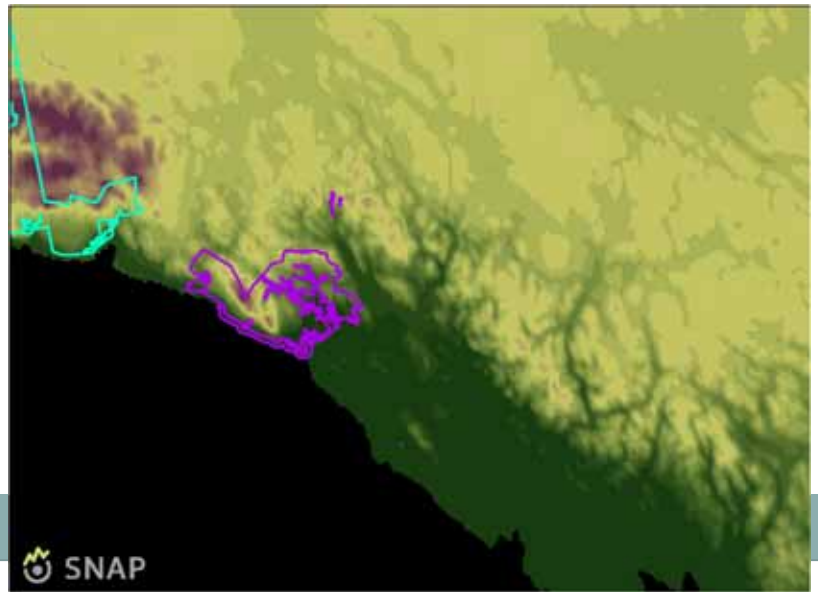

TEMP (*F)
below -21
-21 - -18
-18 - -15
-15 - -12
-12 - -9
-9 - -6
-6 - -3
-3-0
1-3
3-6

Projected Length of Unfrozen Season

2010's



2050's



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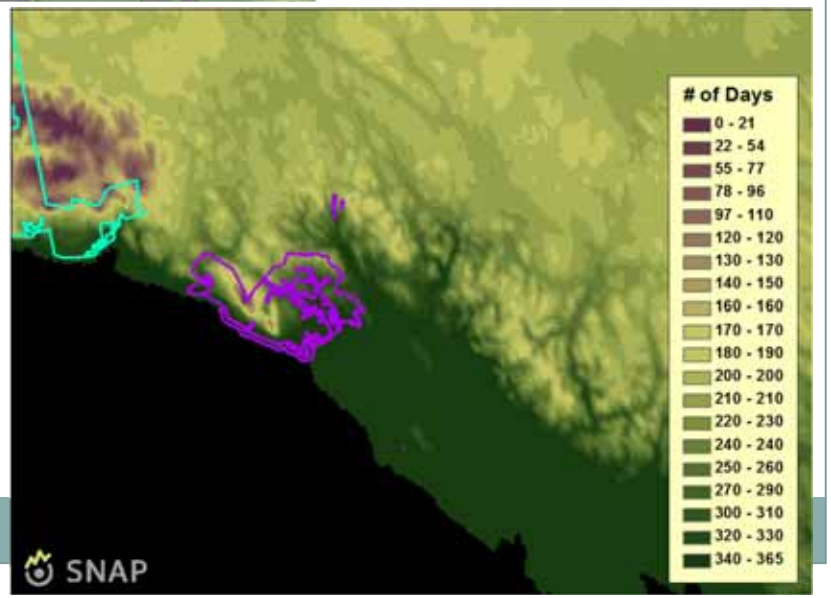
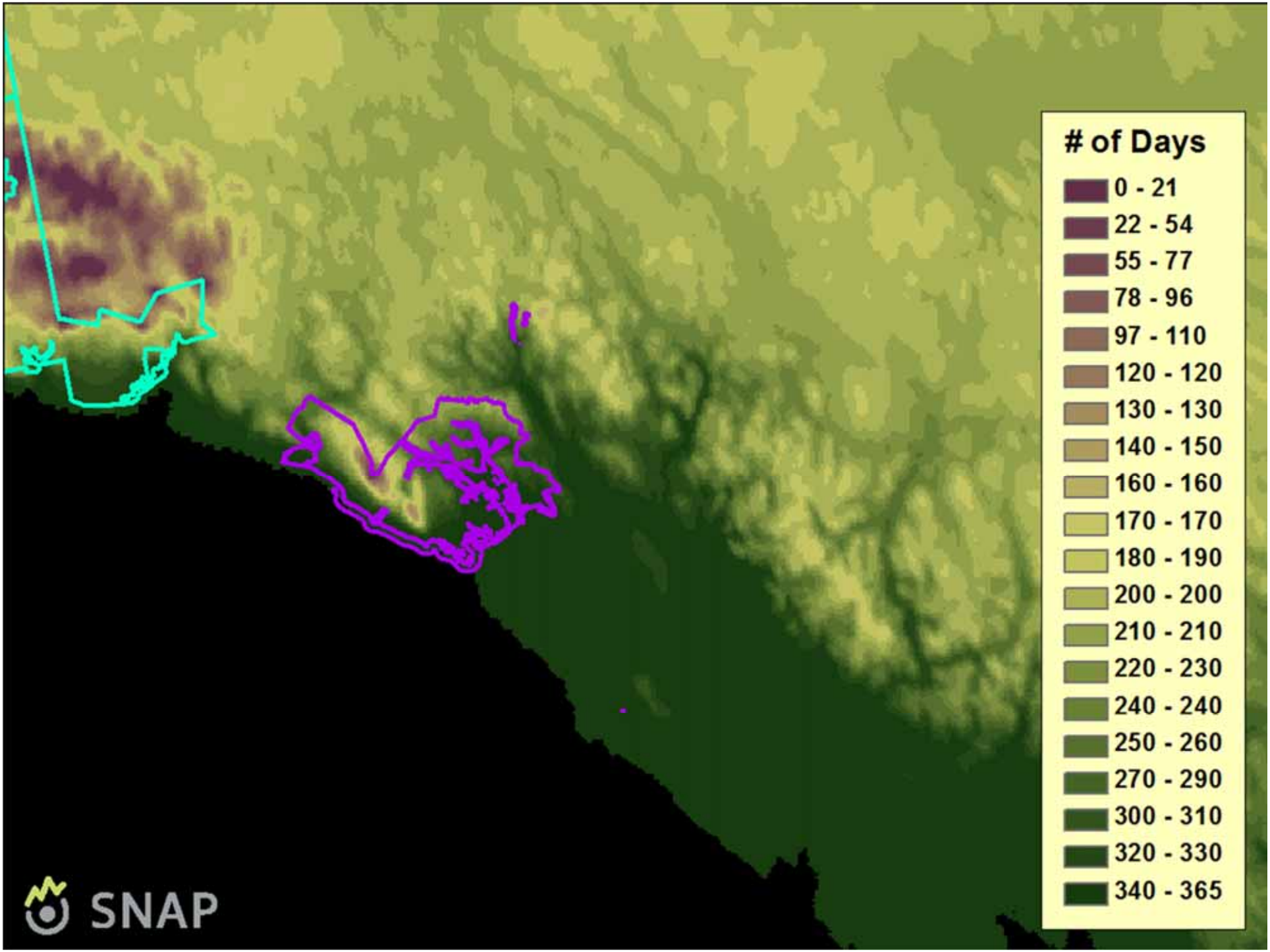


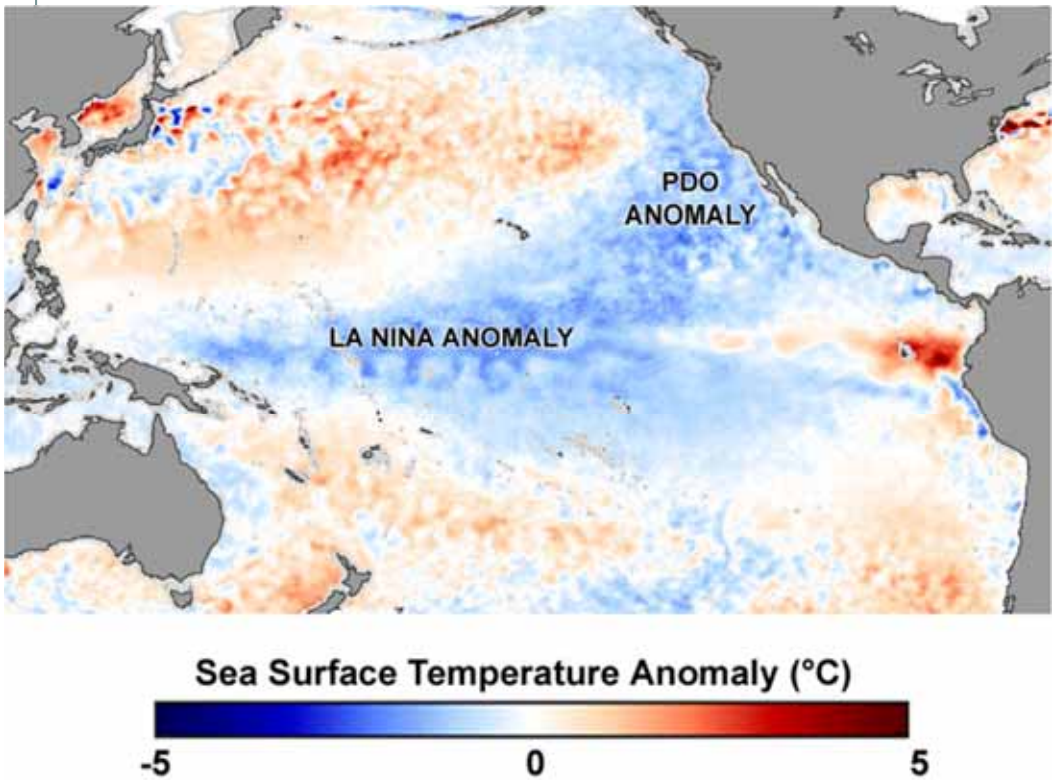

# of Days
0 - 21
22 - 54
55 - 77
78 - 96
97 - 110
120 - 120
130 - 130
140 - 150
160 - 160
170 - 170
180 - 190
200 - 200
210 - 210
220 - 230
240 - 240
250 - 260
270 - 290
300 - 310
320 - 330
340 - 365
SNAP

Drivers are linked to effects

Climate effects are the outcomes of the critical forces or drivers, as expressed by significant changes in particular parks. Points to consider include:

- Time frame (20 years? 100 years?)
- Uncertainty (of both driver and effect)
- Severity of effect (and reversibility)
- Scope: what parks, who is impacted?
- Repercussions: what is the story?
- Feedback to policy

Pacific Decadal Oscillation (PDO)



http://en.wikipedia.org/wiki/File:La_Nina_and_Pacific_Decadal_Anomalies_-_April_2008.png

Pattern of Pacific climate variability that shifts phases about every 20 to 30 years (compared to 6-18 months for ENSO)

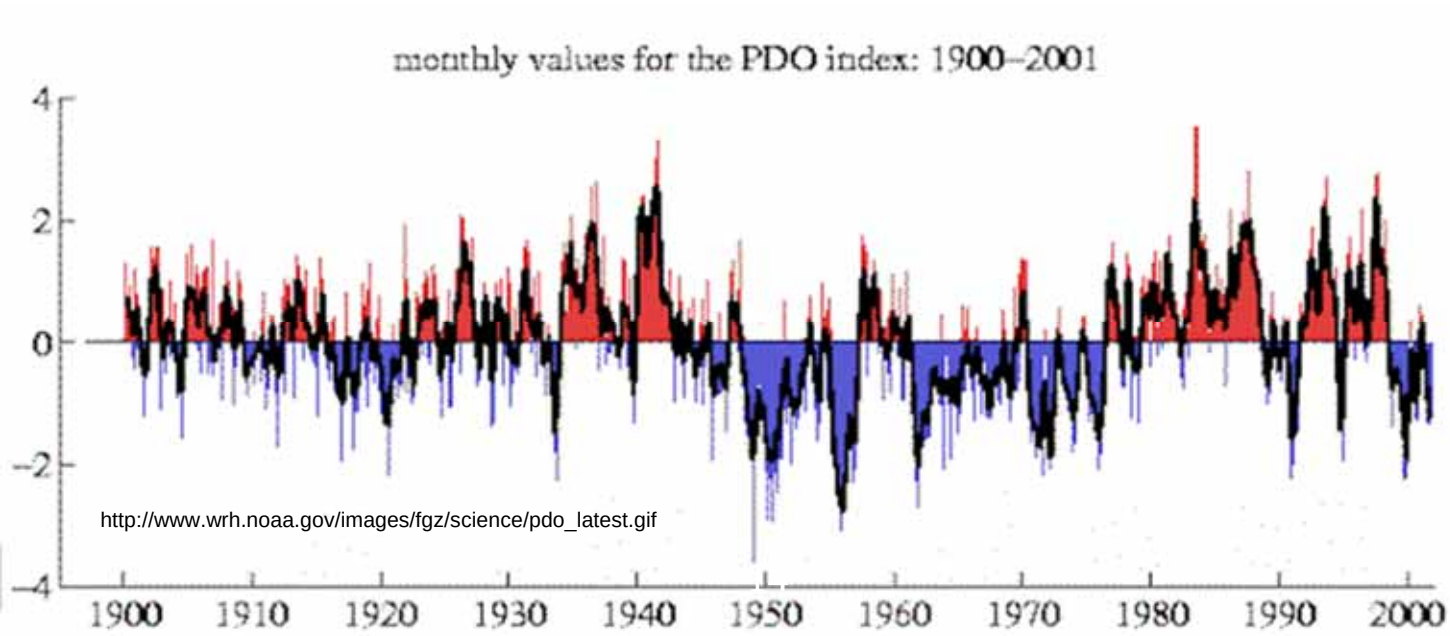
First identified by Steven R. Hare in 1997.

Warm or cool surface waters in the Pacific Ocean, north of 20° N.

In a "warm", or "positive", phase, the west Pacific becomes cool and part of the eastern ocean warms; during a "cool" or "negative" phase, the opposite occurs.

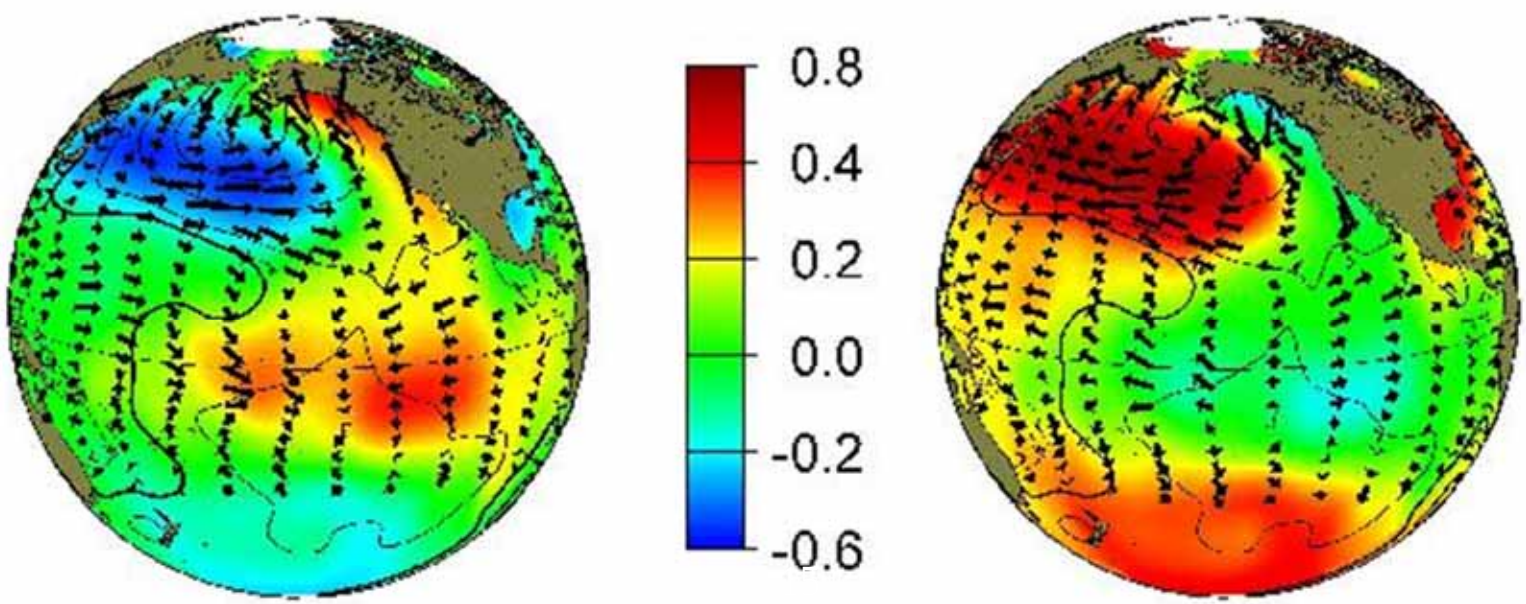
PDO -- Effects

- Major changes in marine ecosystems correlated with PDO.
- Warm eras have seen enhanced coastal ocean productivity in Alaska and inhibited productivity off the west coast of the contiguous United States.
- Cold PDO eras have seen the opposite.



PDO -- Predictability

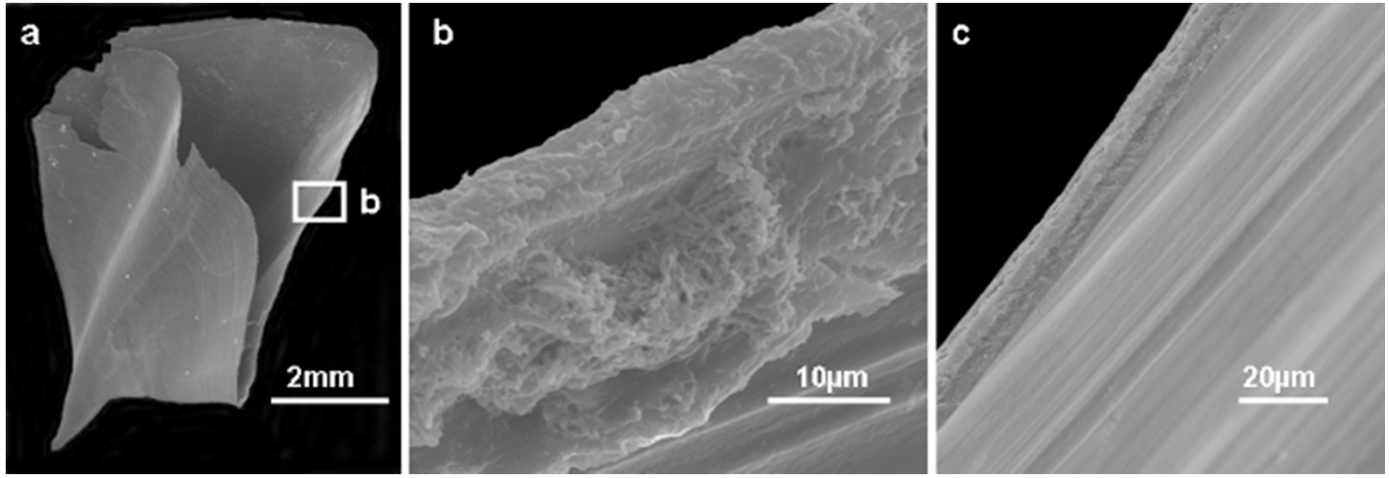
- PDO is caused by several processes with different origins, including ENSO and more stochastic influences .
- Currently NOAA has limited ability to predict PDO more than 1 year out.
- Controversy exists over how PDO works, and how it might best be monitored, modeled and predicted.
- Predictive strength may be improving.



http://jisao.washington.edu/pdo/

Ocean Acidification

Reduced survival of larval marine species
Algae and zooplankton reduced
Serious consequences for food webs
Exact thresholds unclear



Sea Level and Storm Surges

Along the southern shores of Alaska the effect so far is hardly noticeable, because most of the coastline also is slowly rising due to tectonic forces and isostatic rebound.

On the Bering Sea coast and in the Arctic, however, communities are experiencing increased damage from storm surges (extreme high water events caused by high winds and low atmospheric pressure), shoreline loss to fierce winter storms, and saltwater intrusion into freshwater sources, sanitation lagoons, and fish and wildlife habitats.

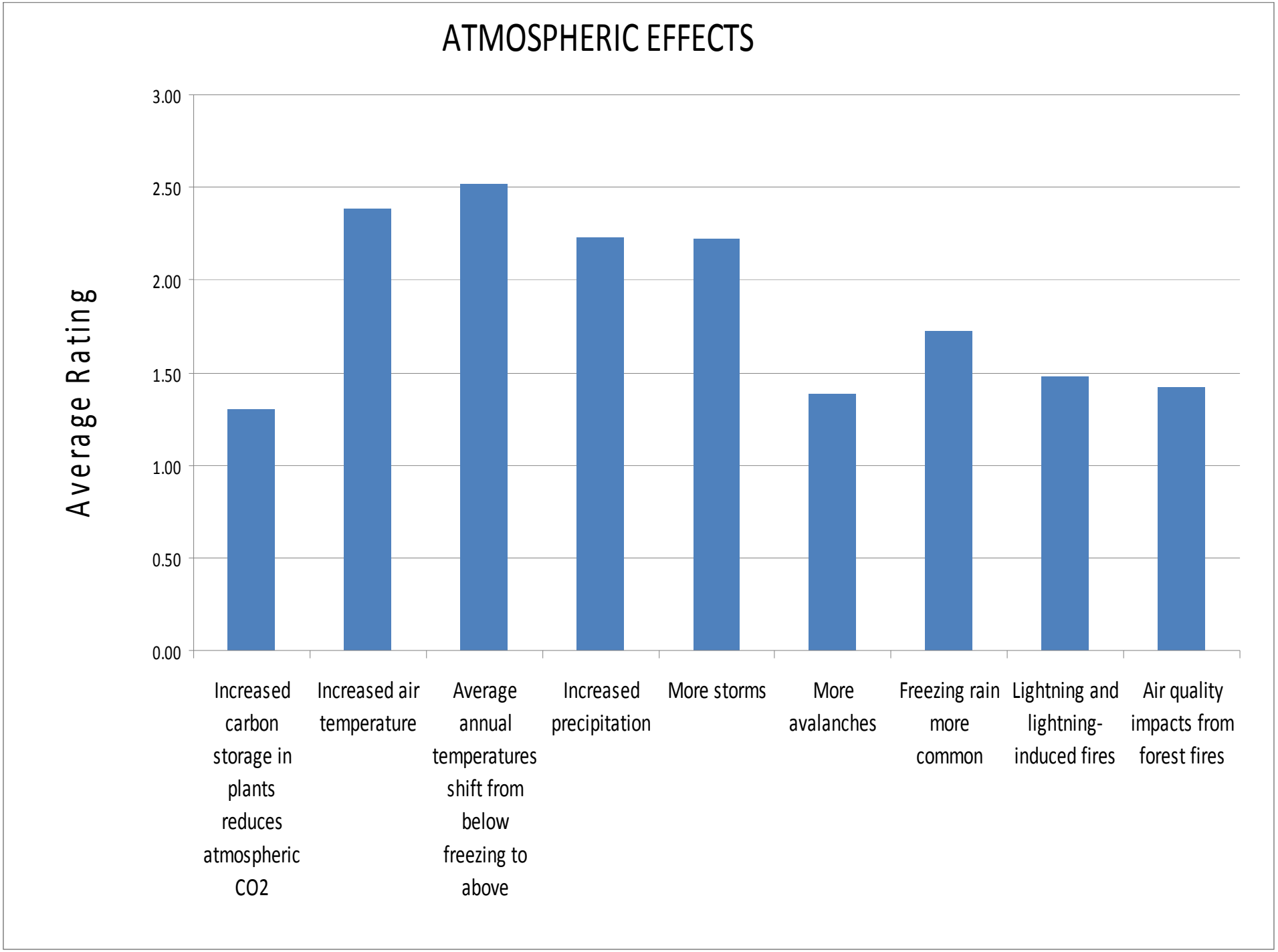
http://seagrant.uaf.edu/map/climate/docs/sea-level.pdf

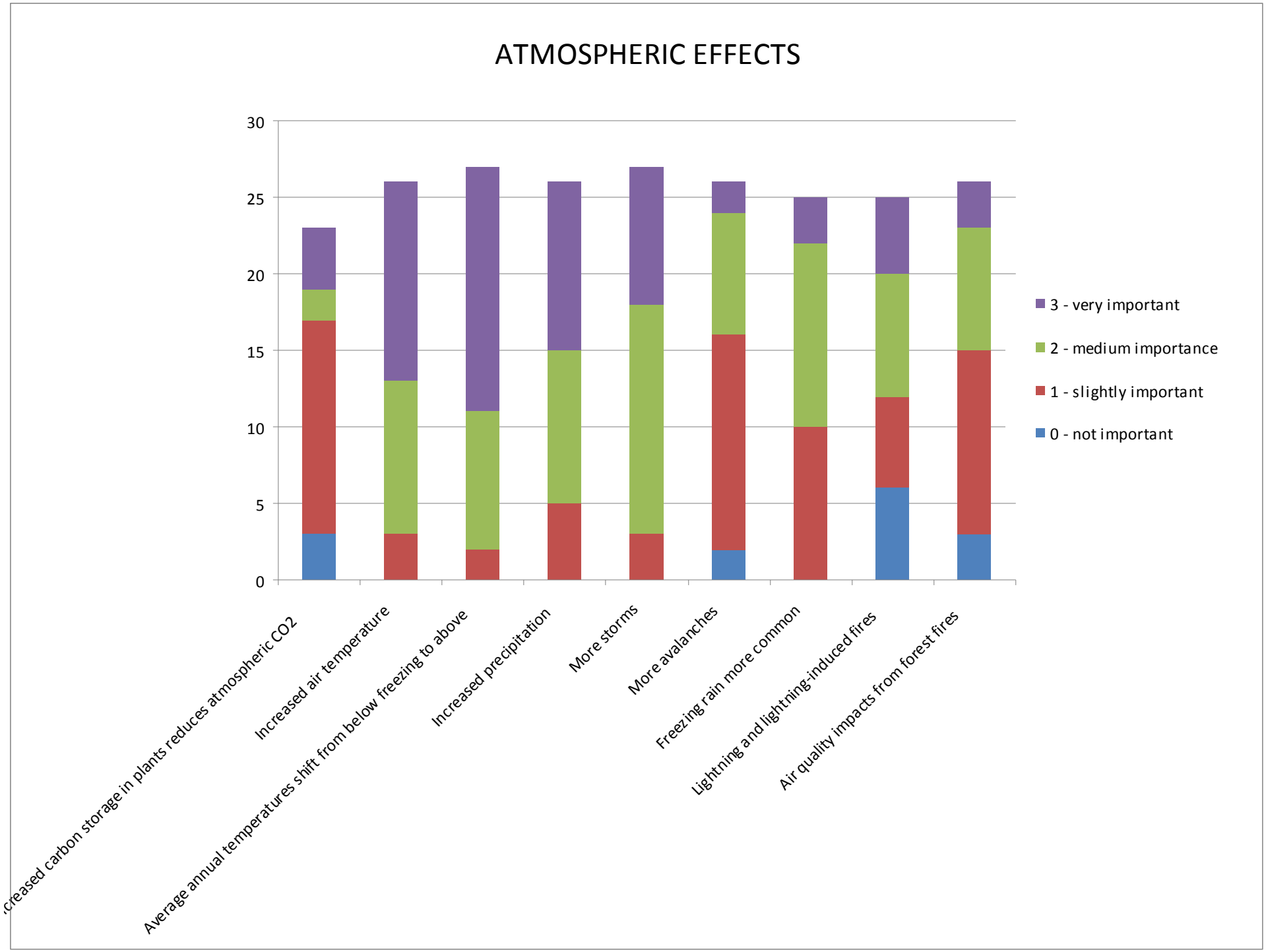
Indications are that all of this is being made worse by a gradual rise in sea level.

Survey Results

- Survey asked only about the IMPORTANCE of various effects
- In selecting drivers, we will also consider the UNCERTAINTY
- Time frame is also an important consideration
- Not all participants responded to the survey (27 responses as of this morning)

SurveyMonkey.com
because knowledge is everything


ATMOSPHERIC EFFECTS
Average Rating
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Increased carbon storage in plants reduces atmospheric CO2
Increased air temperature
Average annual temperatures shift from below freezing to above
Increased precipitation
More storms
More avalanches
Freezing rain more common
Lightning and lightning-induced fires
Air quality impacts from forest fires


ATMOSPHERIC EFFECTS
30
25
20
15
10
5
0
3 - very important
2 - medium importance
1 - slightly important
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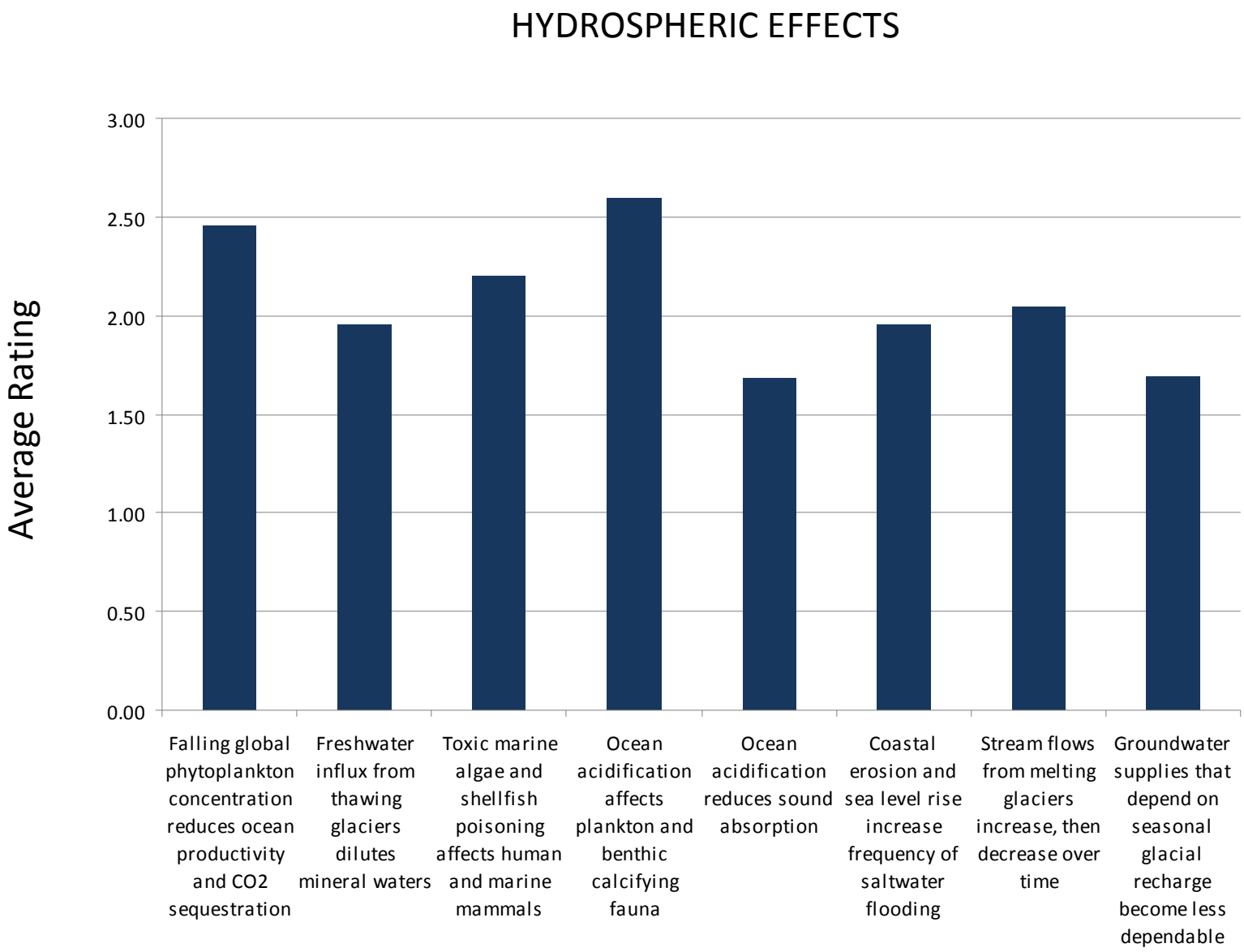
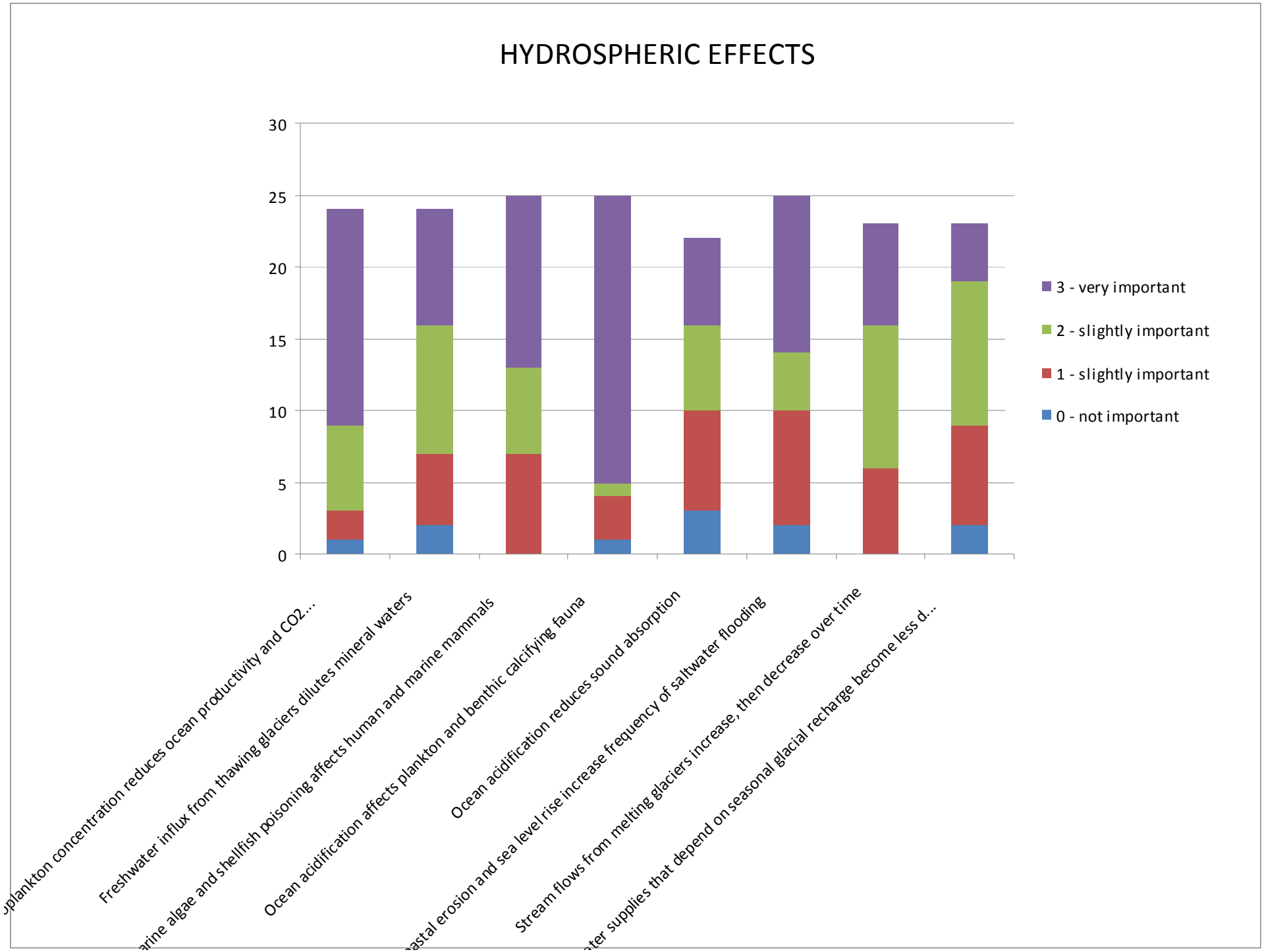

HYDROSPHERIC EFFECTS
Average Rating
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Falling global phytoplankton concentration reduces ocean productivity and CO2 sequestration
Freshwater influx from thawing glaciers dilutes mineral waters
Toxic marine algae and shellfish poisoning affects human and marine mammals
Ocean acidification affects plankton and benthic calcifying fauna
Ocean acidification reduces sound absorption
Coastal erosion and sea level rise increase frequency of saltwater flooding
Stream flows from melting glaciers increase, then decrease over time
Groundwater supplies that depend on seasonal glacial recharge become less dependable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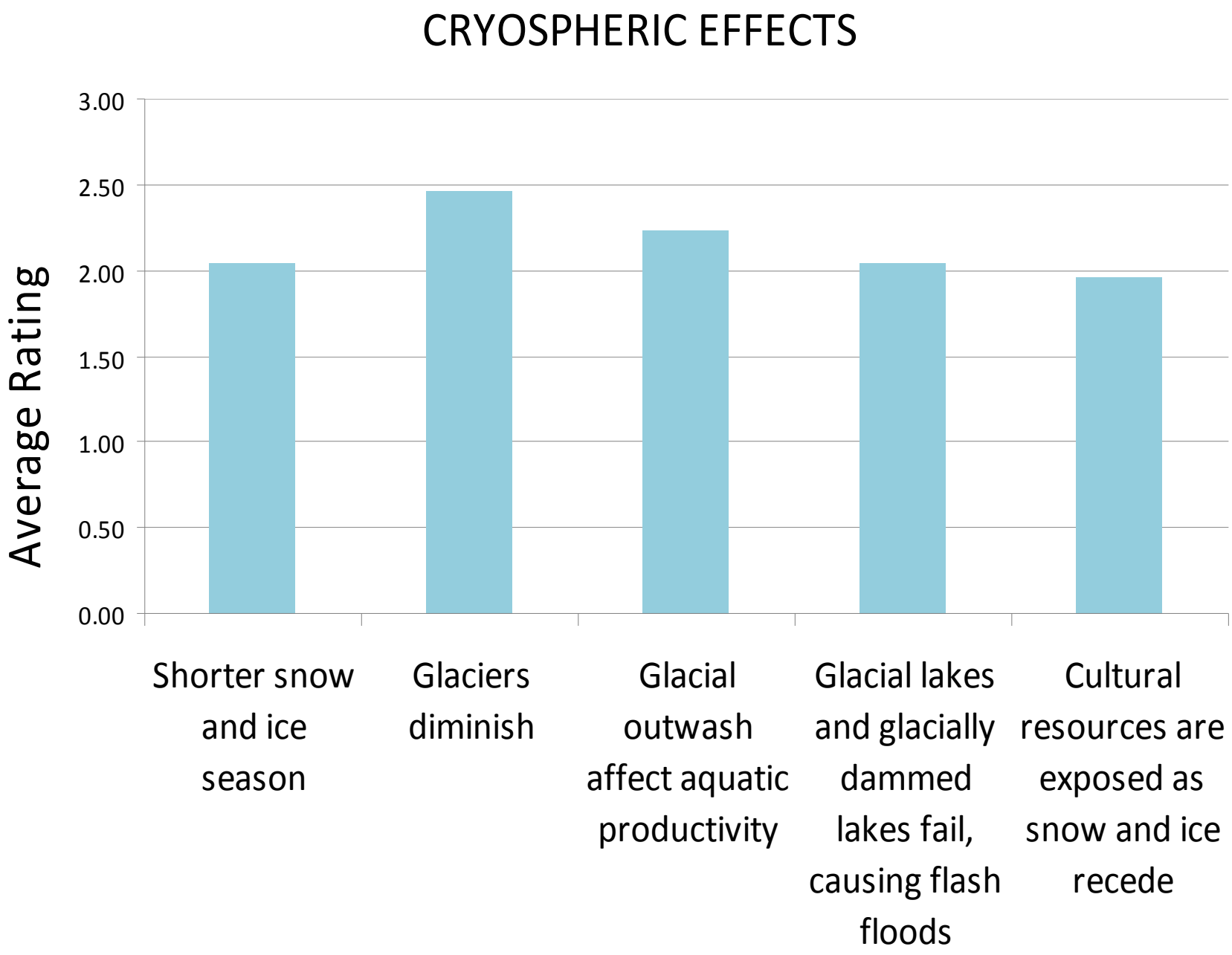
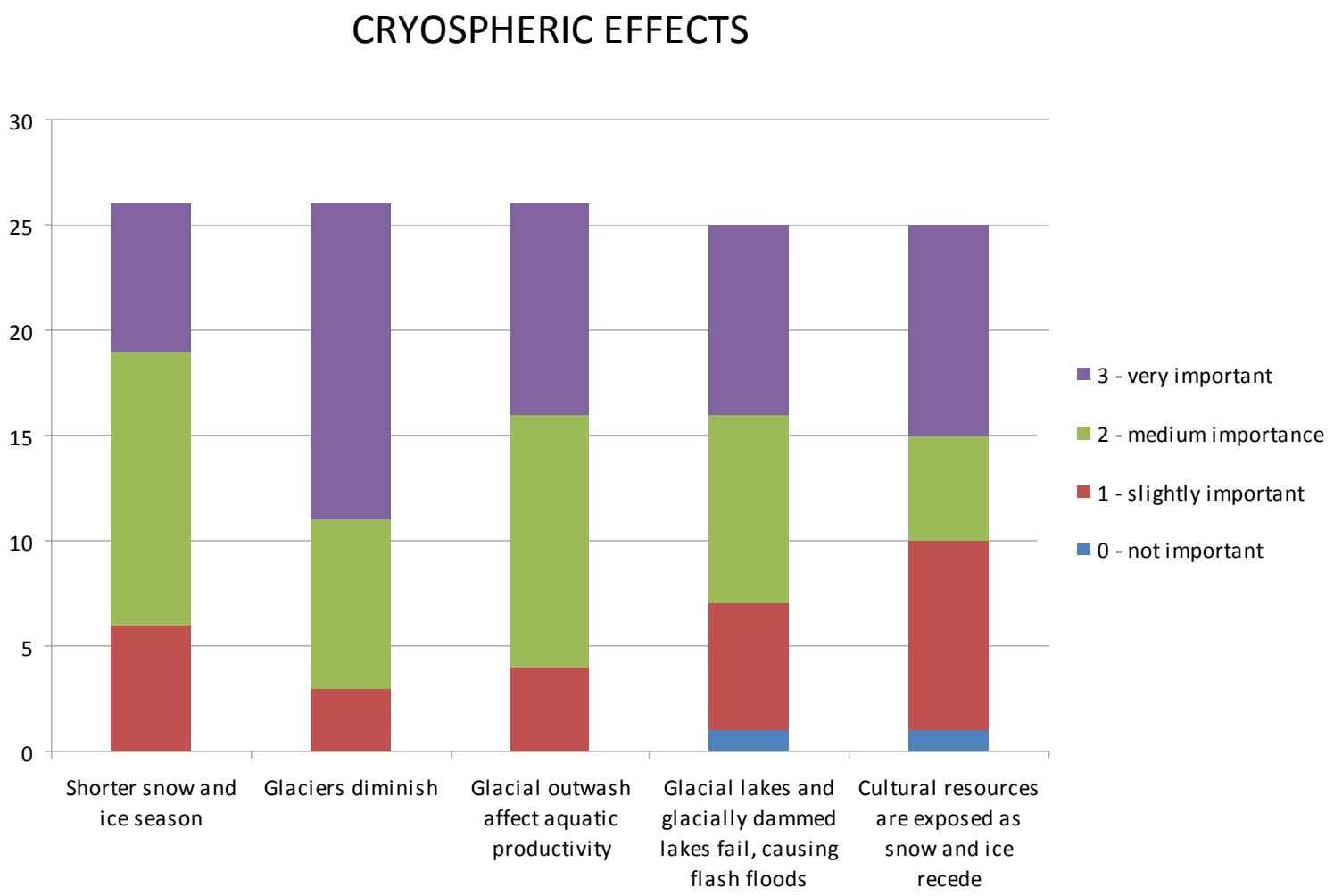

CRYOSPHERIC EFFECTS
Average Rating
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Shorter snow and ice season
Glaciers diminish
Glacial outwash affect aquatic productivity
Glacial lakes and glacially dammed lakes fail, causing flash floods
Cultural resources are exposed as snow and ice recede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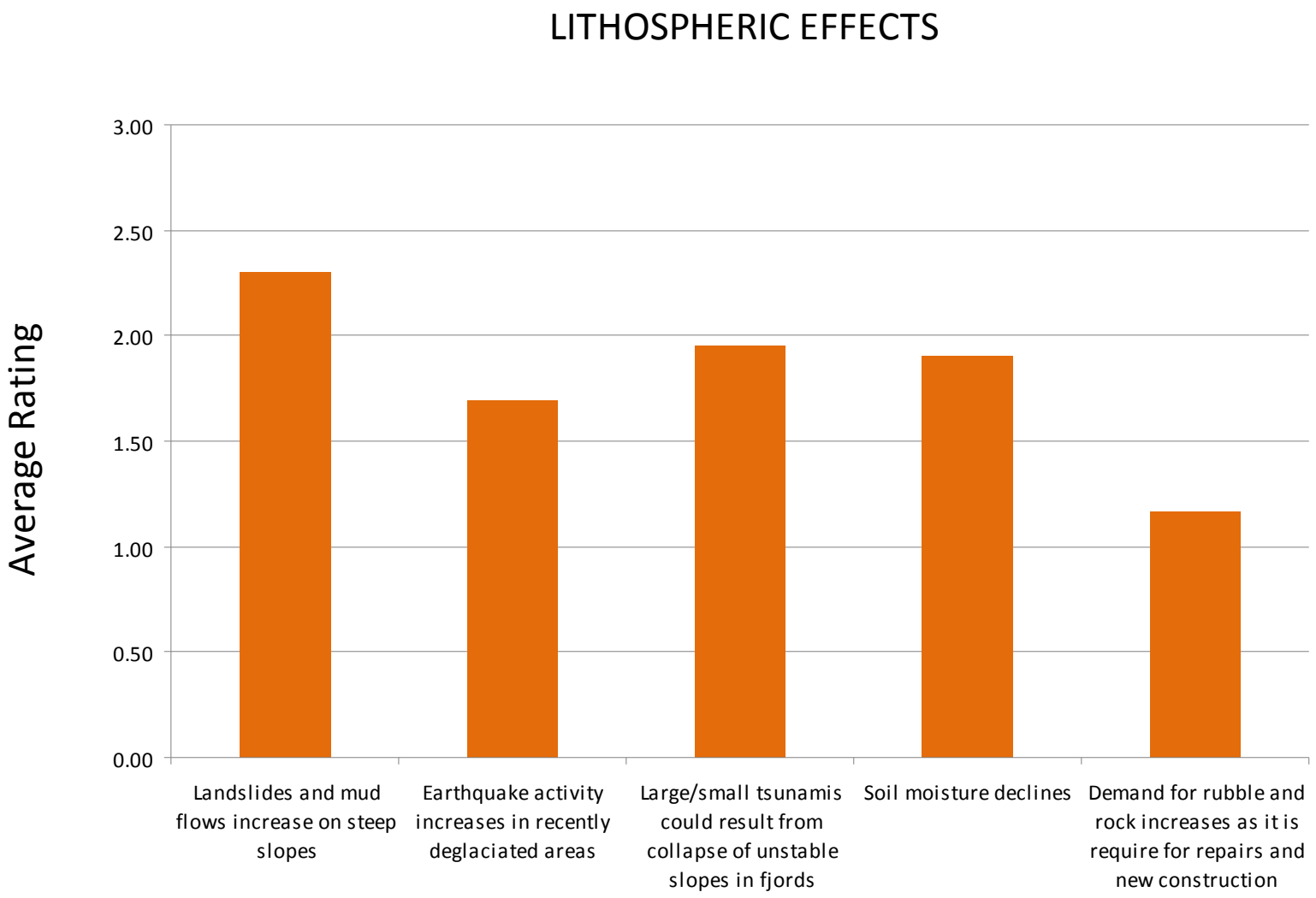
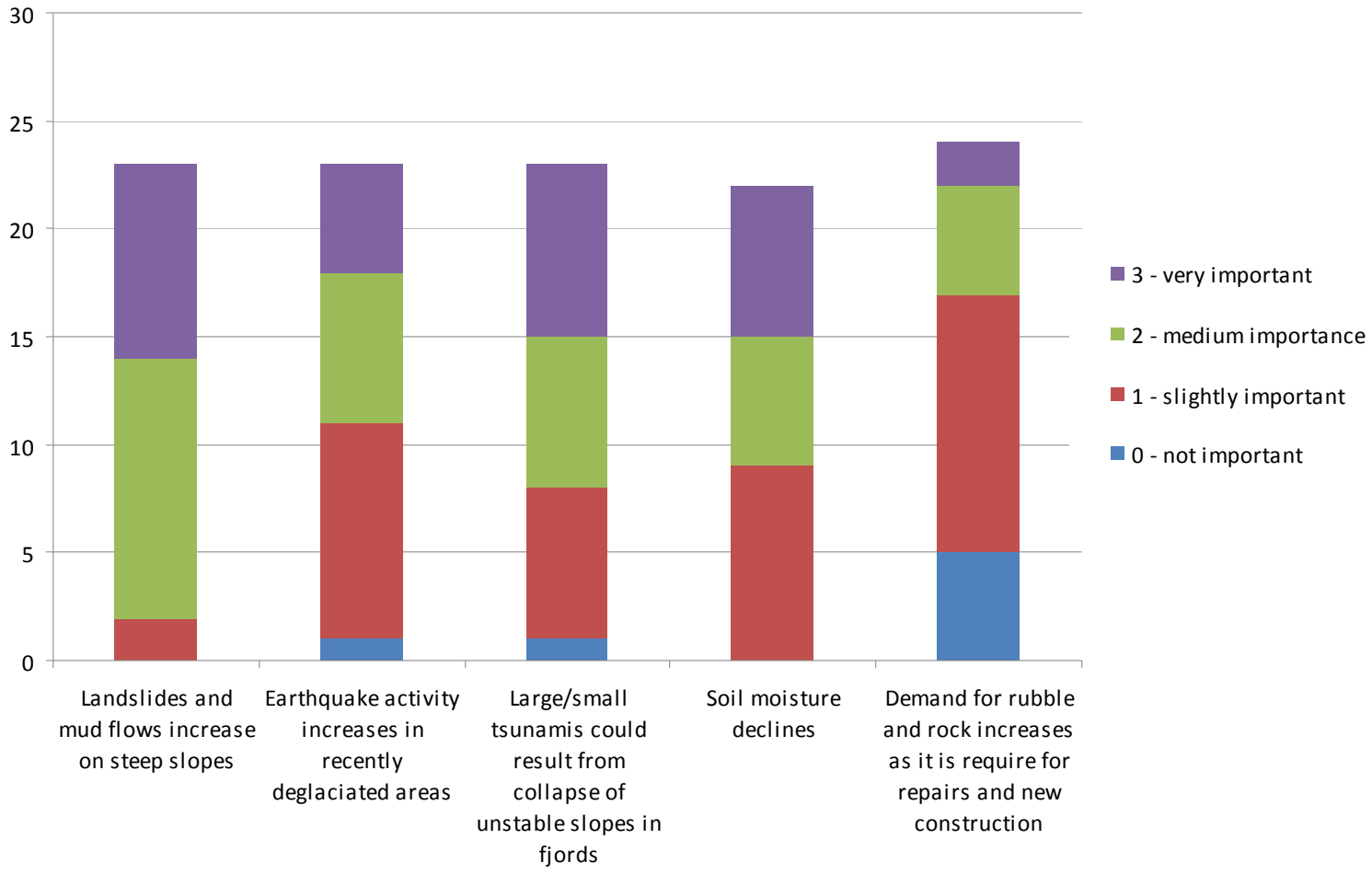
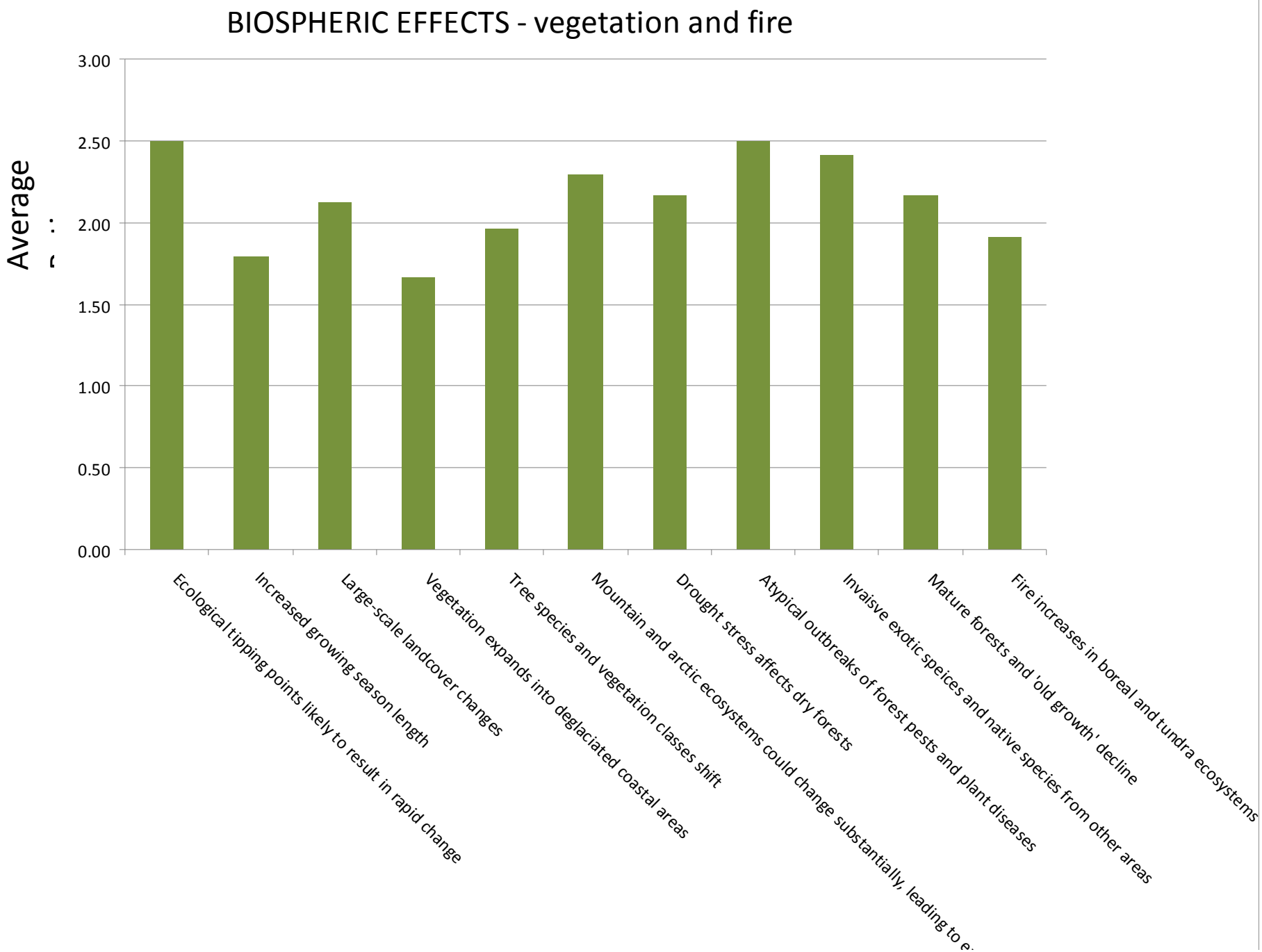
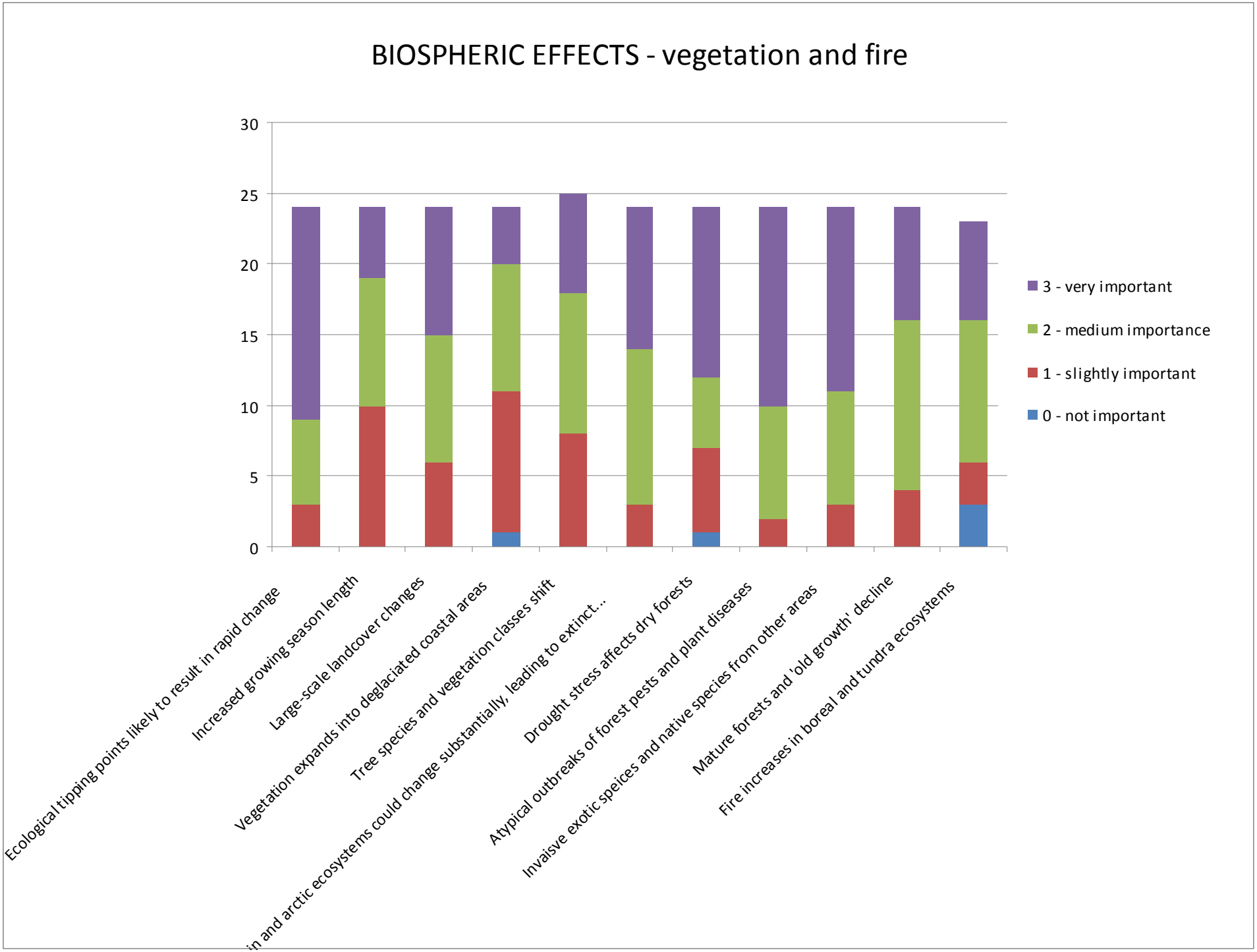

LITHOSPHERIC EFFECTS
Average Rating
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Landslides and mud flows increase on steep slopes
Earthquake activity increases in recently deglaciated areas
Large/small tsunamis could result from collapse of unstable slopes in fjords
Soil moisture declines
Demand for rubble and rock increases as it is require for repairs and new construction

LITHOSPHERIC EFFECTS




BIOSPHERIC EFFECTS - vegetation and fire
Average
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Ecological tipping points likely to result in rapid change
Increased growing season length
Large-scale landcover changes
Vegetation expands into deglaciated coastal areas
Tree species and vegetation classes shift
Mountain and arctic ecosystems could change substantially, leading to e
Drought stress affects dry forests
Atypical outbreaks of forest pests and plant diseases
Invaisve exotic speices and native species from other areas
Mature forests and 'old growth' decline
Fire increases in boreal and tundra ecosystems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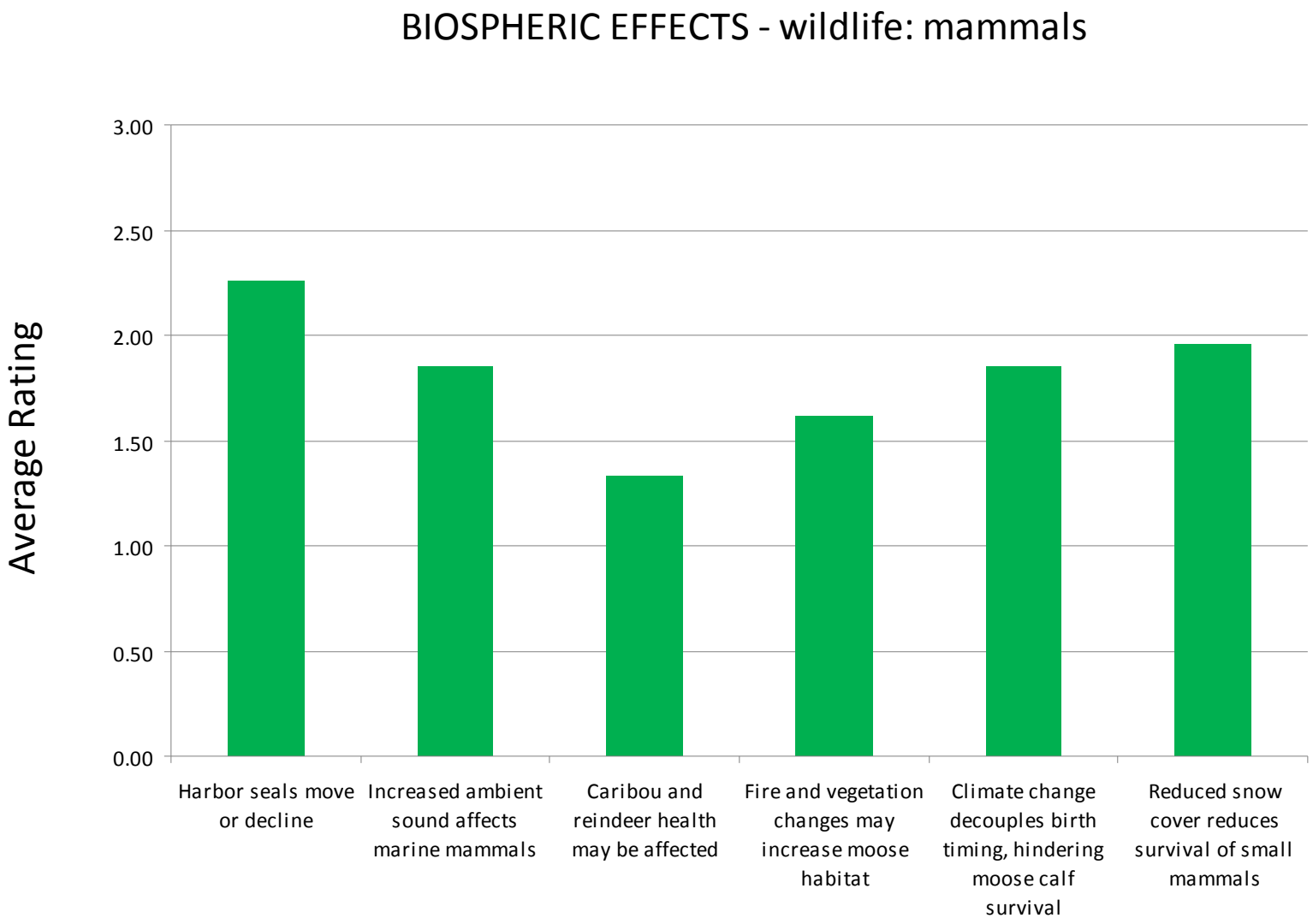
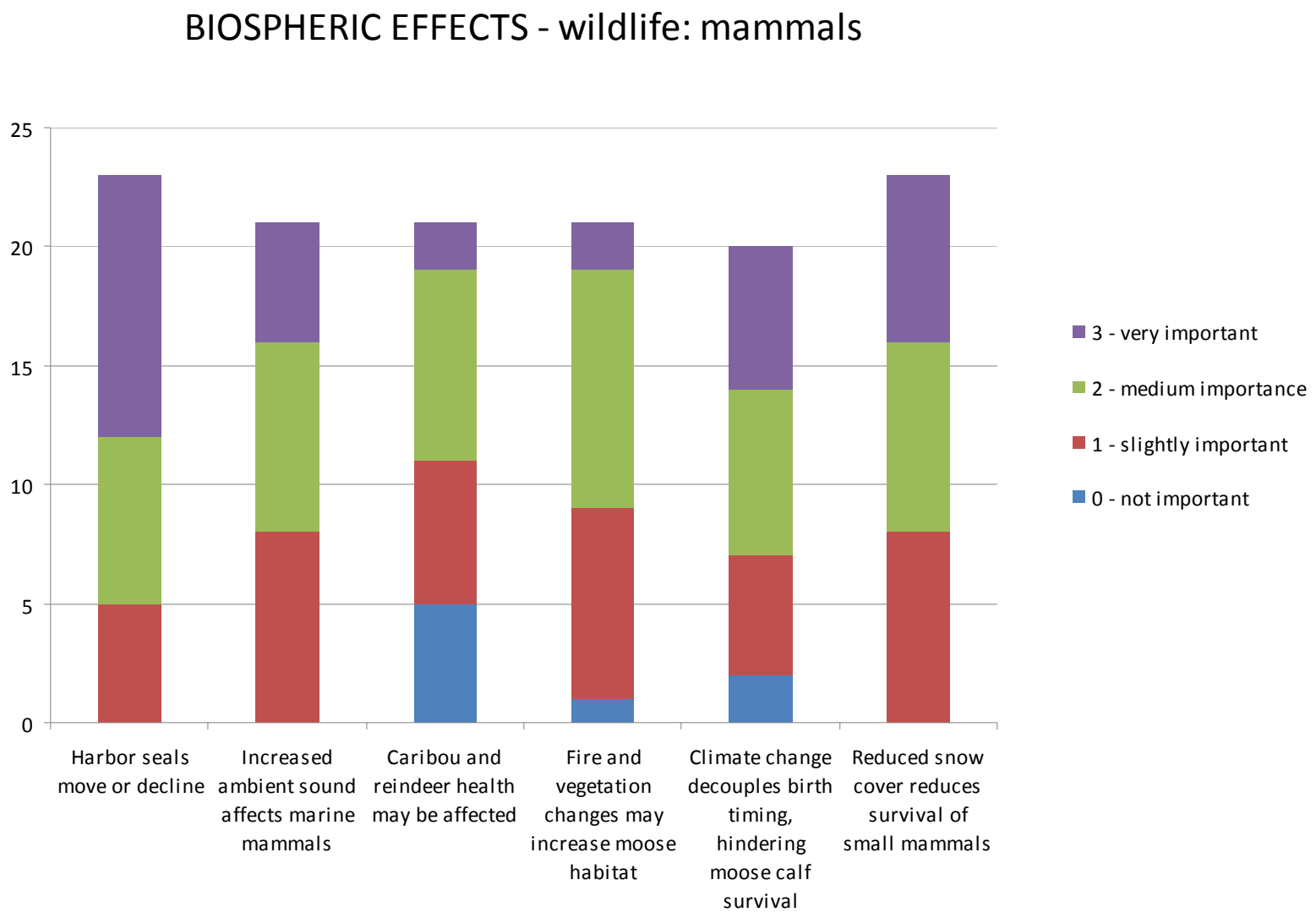

BIOSPHERIC EFFECTS - wildlife: mammals
Average Rating
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Harbor seals move or decline
Increased ambient sound affects marine mammals
Caribou and reindeer health may be affected
Fire and vegetation changes may increase moose habitat
Climate change decouples birth timing, hindering moose calf survival
Reduced snow cover reduces survival of small mammals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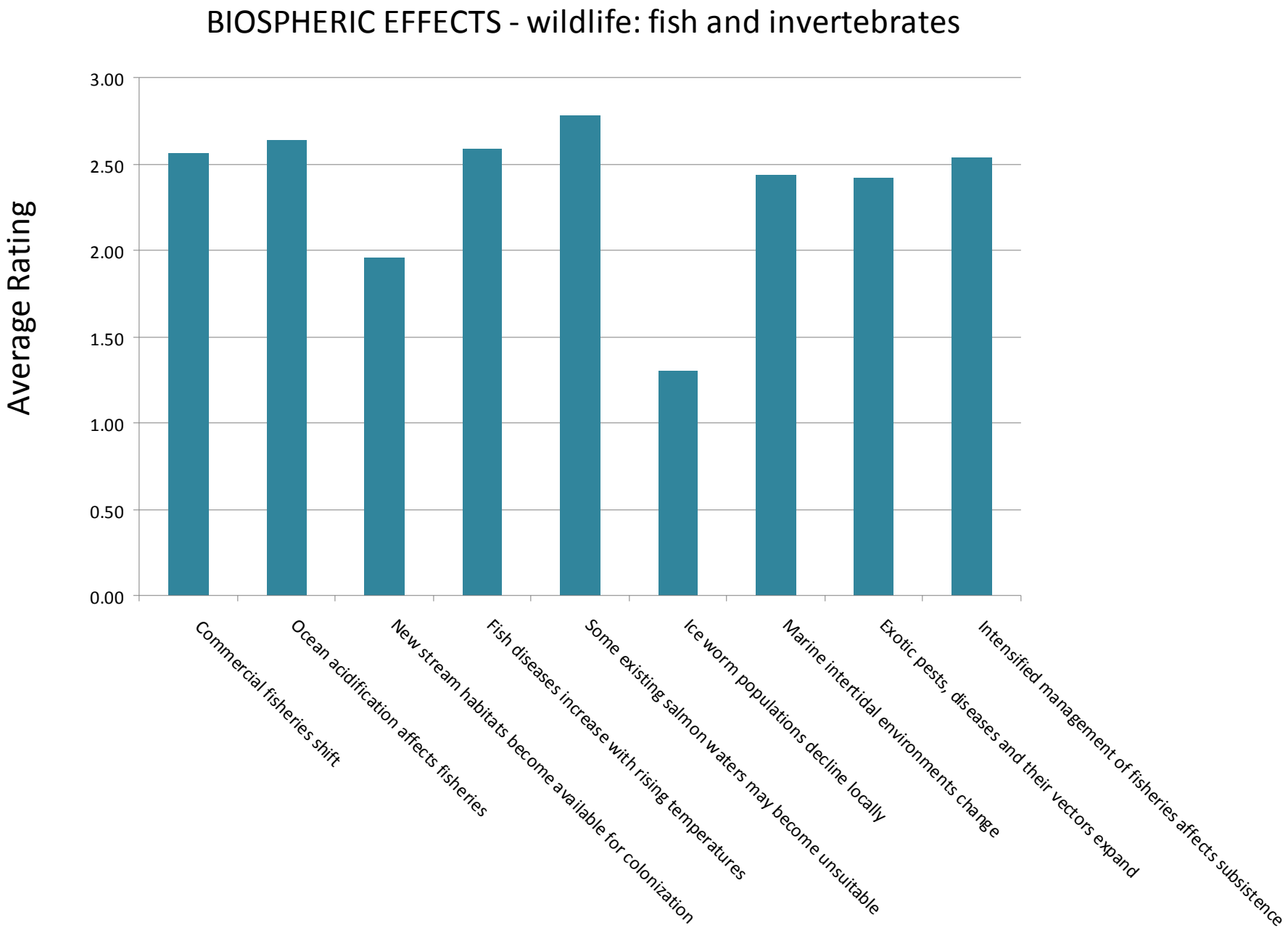
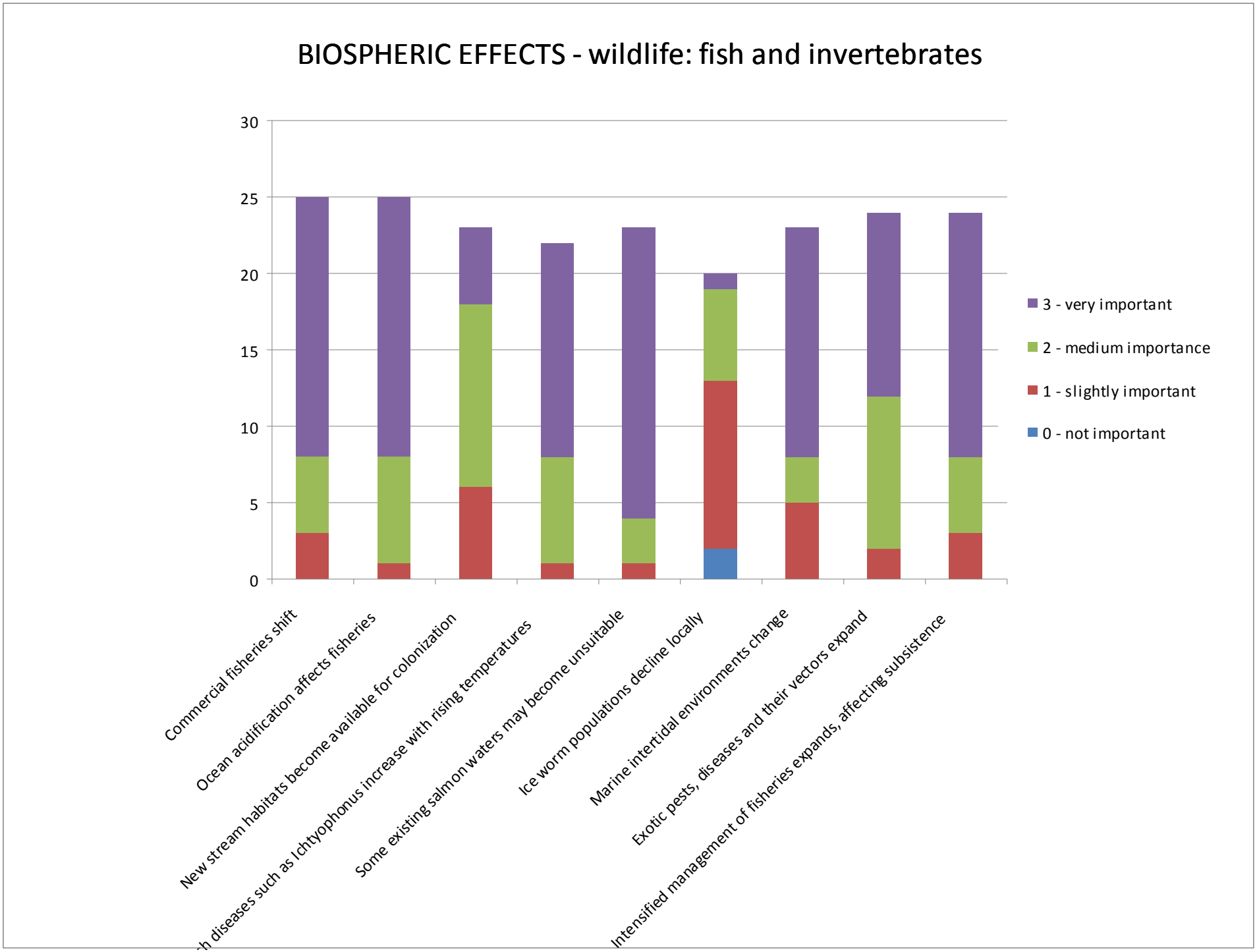

BIOSPHERIC EFFECTS - wildlife: fish and invertebrates
Average Rating
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Commercial fisheries shift
Ocean acidification affects fisheries
New stream habitats become available for colonization
Fish diseases increase with rising temperatures
Some existing salmon waters may become unsuitable
Ice worm populations decline locally
Marine intertidal environments change
Exotic pests, diseases and their vectors expand
Intensified management of fisheries affects subsistence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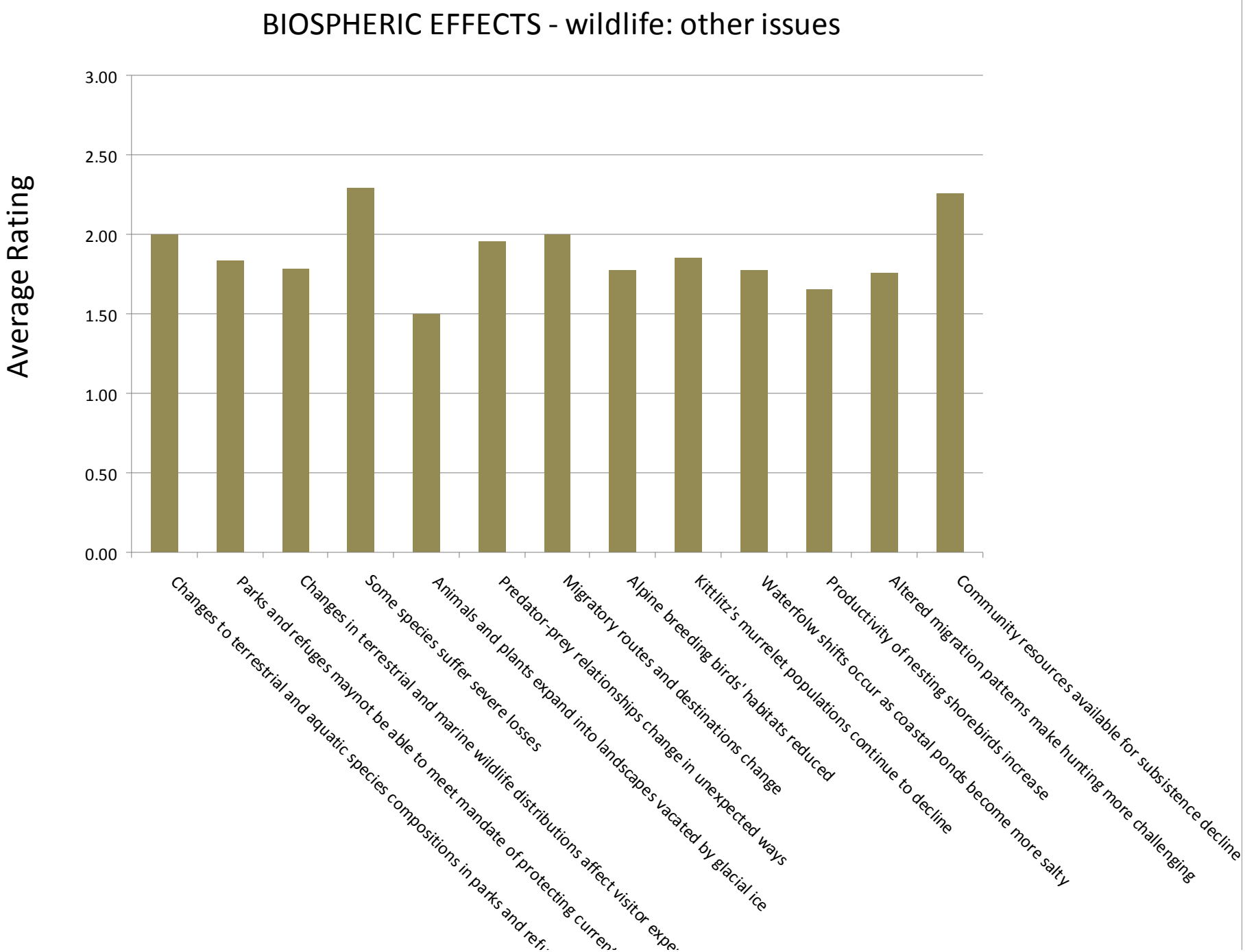
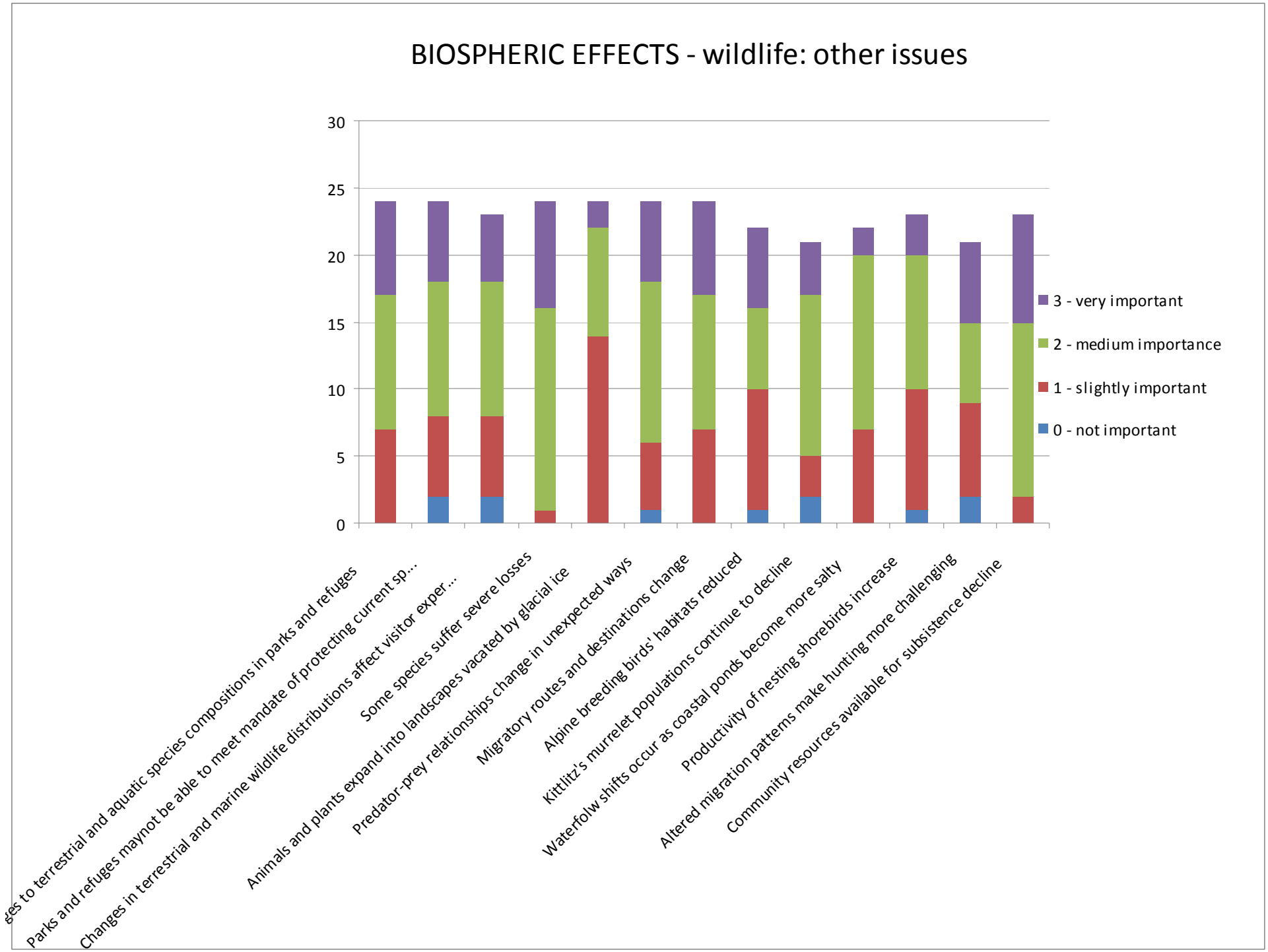

BIOSPHERIC EFFECTS - wildlife: other issues
Average Rating
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Changes to terrestrial and aquatic species compositions in parks and refi
Parks and refuges maynot be able to meet mandate of protecting curren
Changes in terrestrial and marine wildlife distributions affect visitor expe
Some species suffer severe losses
Animals and plants expand into landscapes vacated by glacial ice
Predator-prey relationships change in unexpected ways
Migratory routes and destinations change
Alpine breeding birds' habitats reduced
Kittlitz's murrelet populations continue to decline
Waterfolw shifts occur as coastal ponds become more salty
Productivity of nesting shorebirds increase
Altered migration patterns make hunting more challenging
Community resources available for subsistence decline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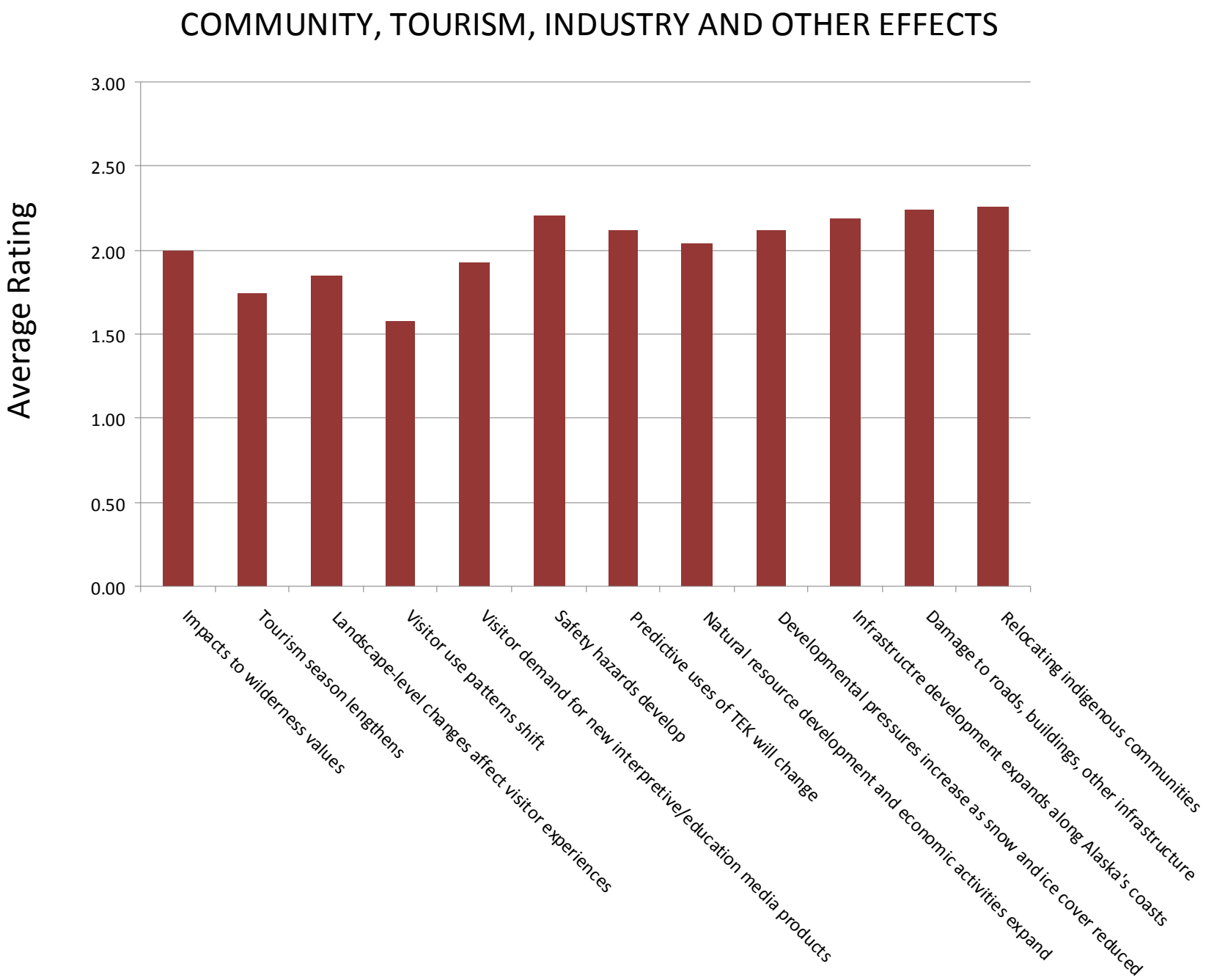
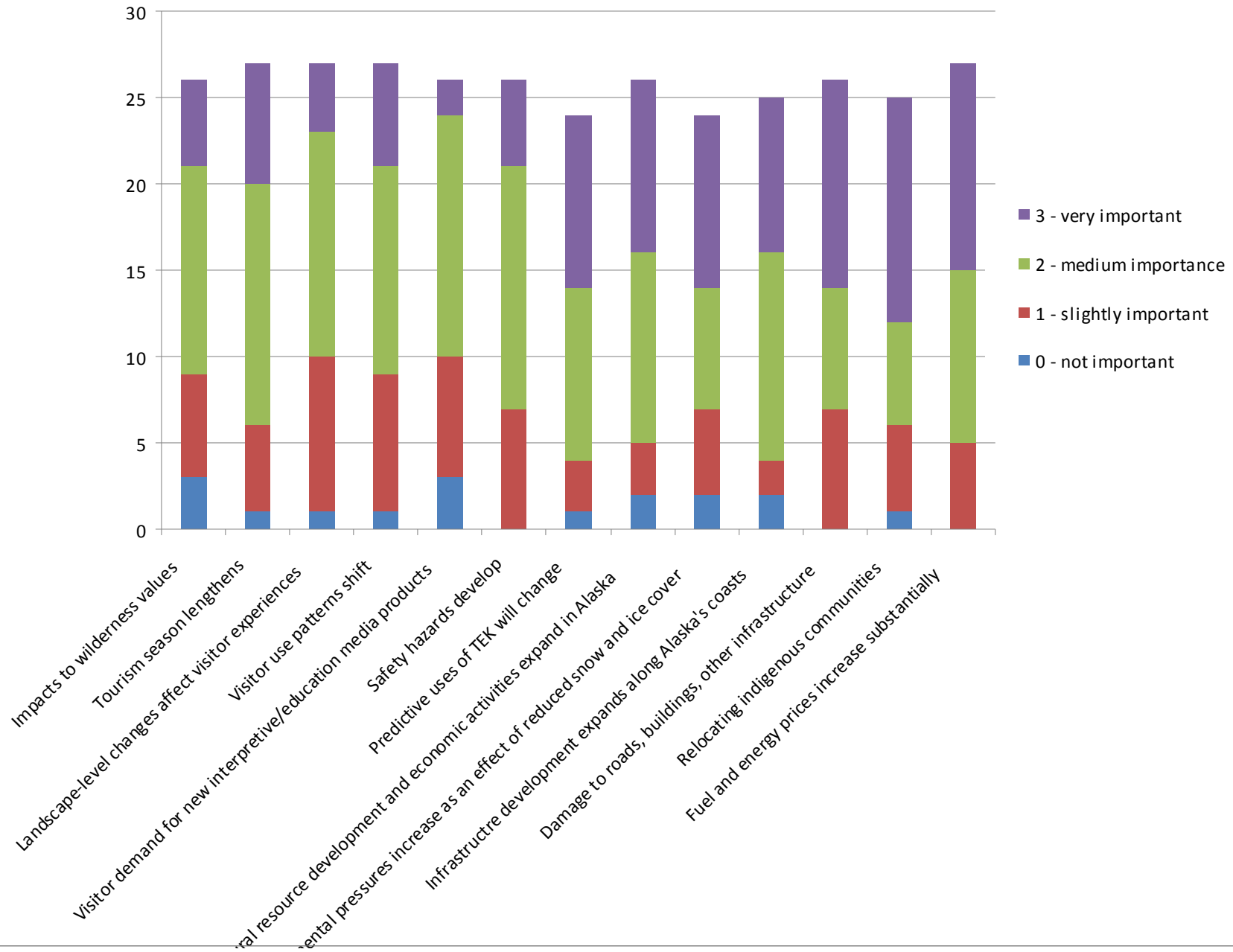

COMMUNITY, TOURISM, INDUSTRY AND OTHER EFFECTS
Average Rating
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Impacts to wilderness values
Tourism season lengthens
Landscape-level changes affect visitor experiences
Visitor use patterns shift
Visitor demand for new interpretive/education media products
Safety hazards develop
Predictive uses of TEK will change
Natural resource development and economic activities expand
Developmental pressures increase as snow and ice cover reduced
Infrastructre development expands along Alaska's coasts
Damage to roads, buildings, other infrastructure
Relocating indigenous communities

COMMUNITY, TOURISM, INDUSTRY AND OTHER EFFECTS



Critical Uncertainties

Southwest Alaska Network (SWAN) group, August workshop

Less	Water availability	More
Normal	Stream/lake temps	Warmer
Less	River basin hydrology	More
Measureable	Ocean Acidification	Catastrophic
Historical	Extreme precip/storms	Significant increase
Negative (colder)	PDO	Positive (warmer)

Climate Drivers

- Climate drivers are the **critical forces** in our scenarios planning process
- Critical forces generally have unusually **high impact** and unusually **high uncertainty**
- Climate drivers table specific for SE Alaska were compiled by John Walsh and Nancy Fresco of SNAP (see handouts).
- All scenarios are created by examining the intersection of two drivers, creating four sectors
- **Selection of drivers** is crucial to the planning process