Archaeological Sites as Nodes in Long-term Ecological Observing Networks

Ben Fitzhugh (UW, fitzhugh@uw.edu)
Anne Jensen (UAF), Kana Nagashima (JAMSTEC)
Thomas H. McGovern (CUNY-Hunter)
Catherine West (BU), Bruce Finney (ISU)
Guðbjörg Ásta Ólafsdóttir (U. Iceland)
George Hambrecht (U. Md), Arkady Savinetsky (RAS)
James Woollett (U. Laval)

Ecosystem Studies of Sub-Arctic Seas — ESSAS

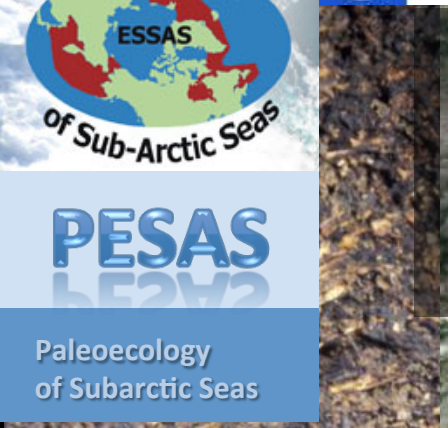
PESAS

Paleoecology of Subarctic Seas

GHEA global human ecodynamics alliance

IHOPE Integrated History and Future of People on Earth

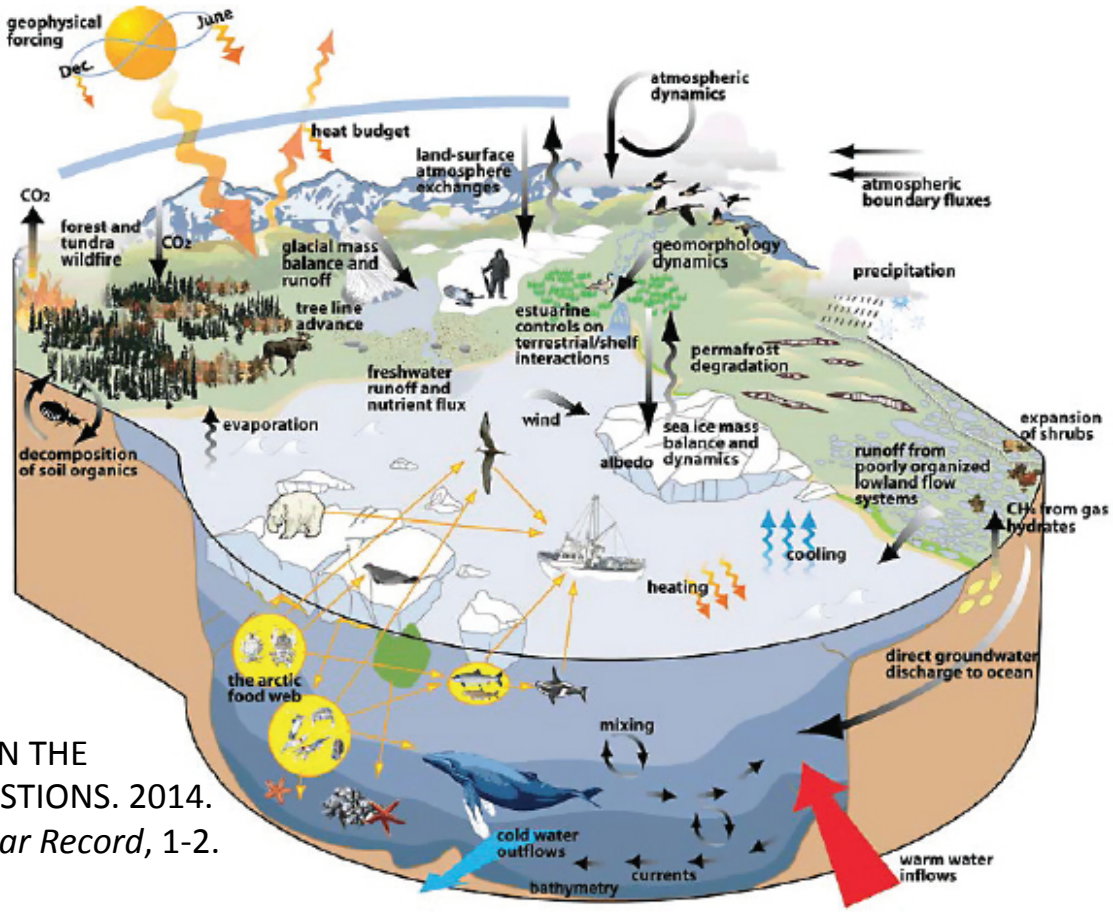
NA BO



Arctic Observing Networks

- "The goal of AON is to enhance the environmental observing infrastructure required for the scientific investigation of Arctic environmental system **change** and its **global** connections."
- **Three key principles**:
  - Systems/Dynamics
  - Time
  - Space
- **Our Argument:**

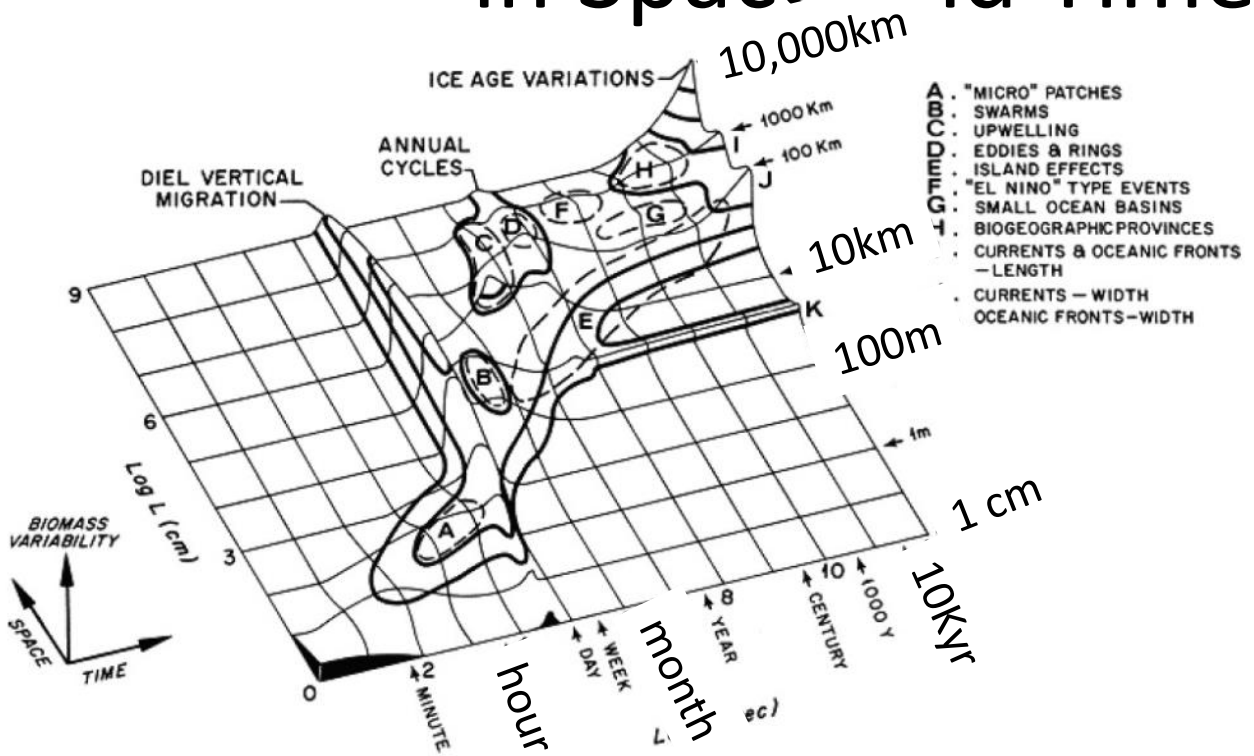
  Archaeological sites are **Distributed Observation Networks of the Past** (DONOPS)



Huntington and Pfirman (eds). THE ARCTIC IN THE ANTHOPOCENE. EMERGING RESEARCH QUESTIONS. 2014. Washington: National Academies Press. *Polar Record*, 1-2.

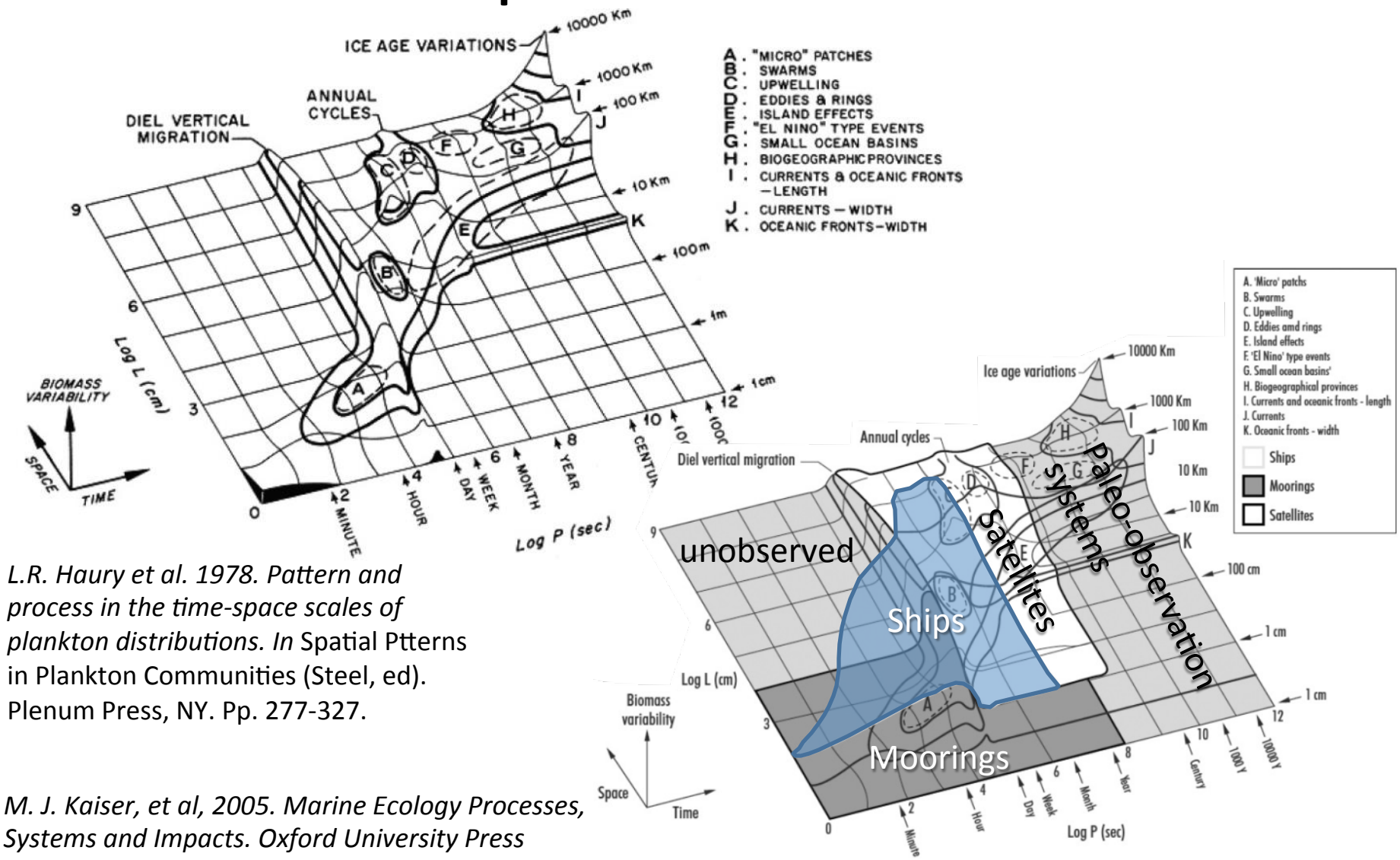
Deeply stratified sites with organic preservation: **“distributed observing networks of the past”**

Observing Marine Ecosystems in Space and Time



L.R. Haury et al. 1978. Pattern and process in the time-space scales of plankton distributions. In Spatial Ptterns in Plankton Communities (Steel, ed). Plenum Press, NY. Pp. 277-327.

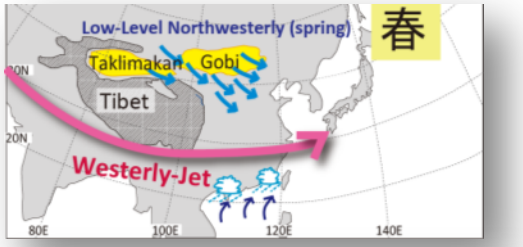
Observing Marine Ecosystems in Space and Time



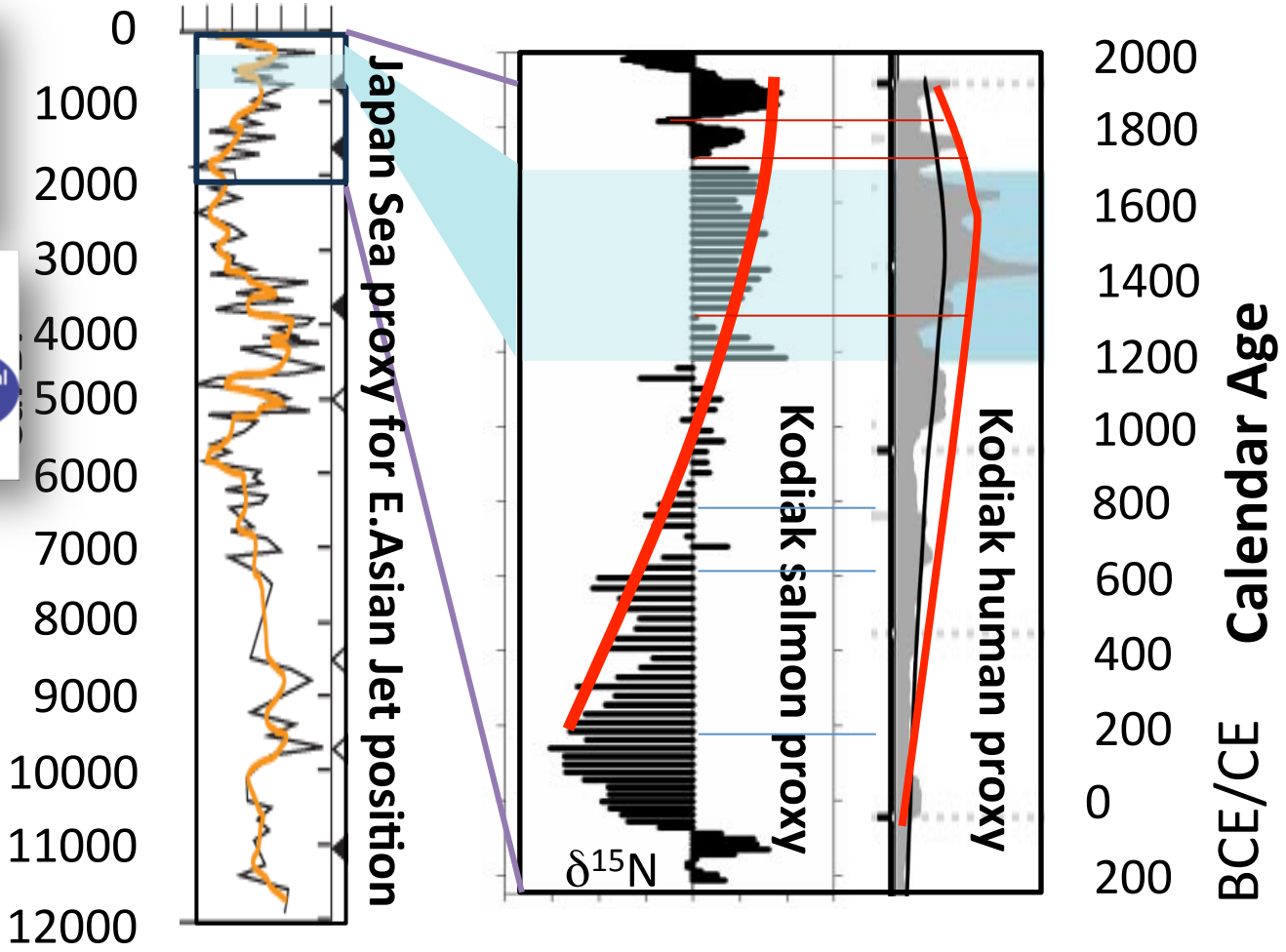
L.R. Haury et al. 1978. Pattern and process in the time-space scales of plankton distributions. In Spatial Ptterns in Plankton Communities (Steel, ed). Plenum Press, NY. Pp. 277-327.

M. J. Kaiser, et al, 2005. Marine Ecology Processes, Systems and Impacts. Oxford University Press

Evidence of millennial scale climate impacts on ecosystems and humans



NE Pacific data supports the idea that populations do better when ecosystems is more productive

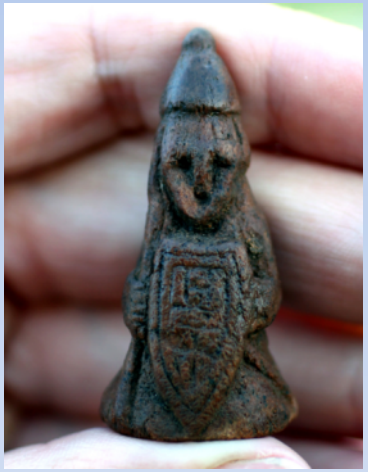


Nagashima Analysis (Harada et al 2014)

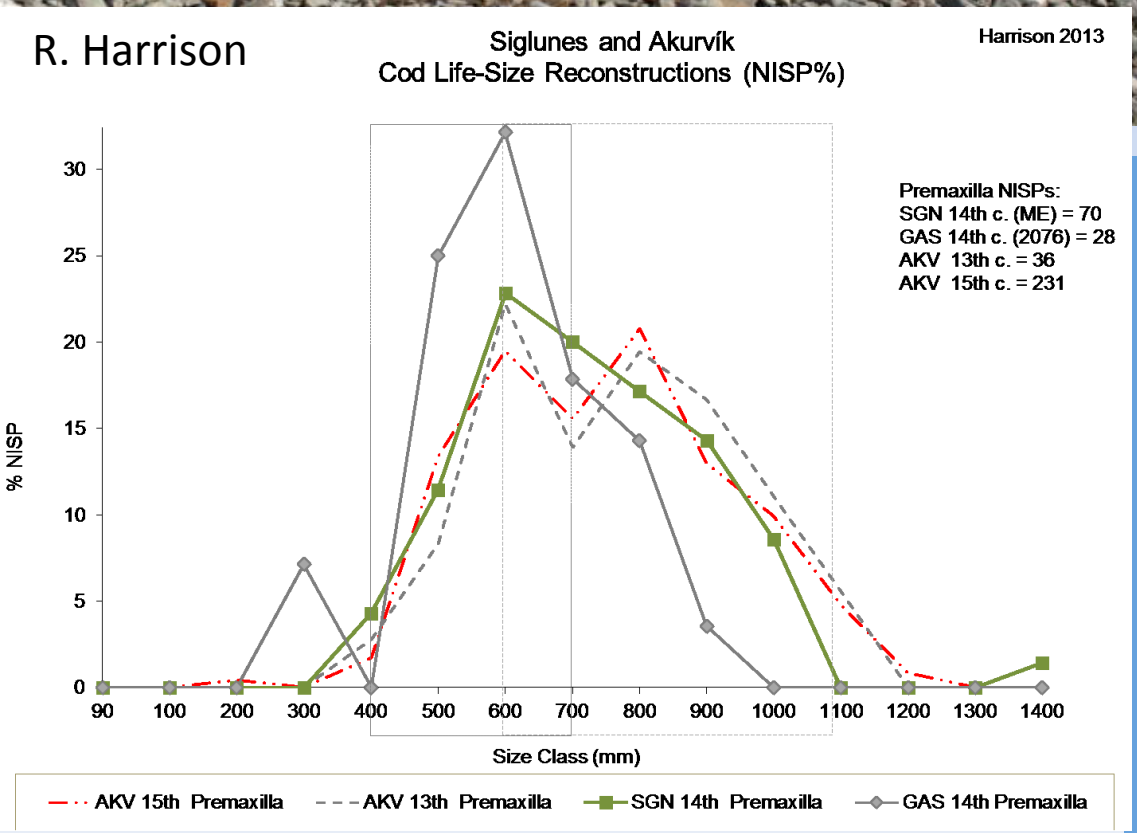
Finney et al. 2002

Fitzhugh et al. in prep

- Good sites can preserve millennial to century scale paleoecological changes:
  - Local “archives” for trend analysis on century to millennial scales.
- Across regions, comparative analysis can reveal long term, spatio-temporal dynamics
  - Distributed networks = System dynamics over time!



R. Harrison



Northern Iceland

Coastal fishing stations

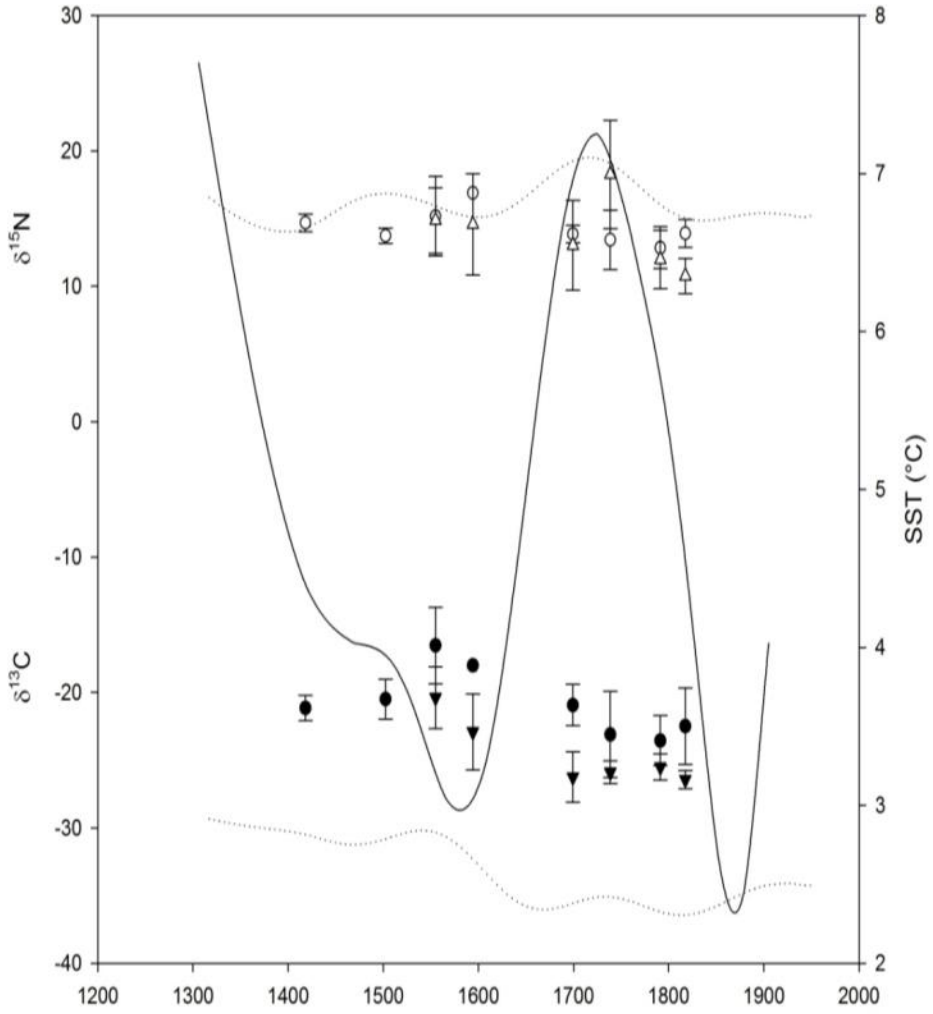
Early 10th c- 14th c dates, extends from first settlement artisanal fishing to early commercial fishing.

Age-size reconstructions, fish cutting reconstruction….

Chessman from Haddock bone….

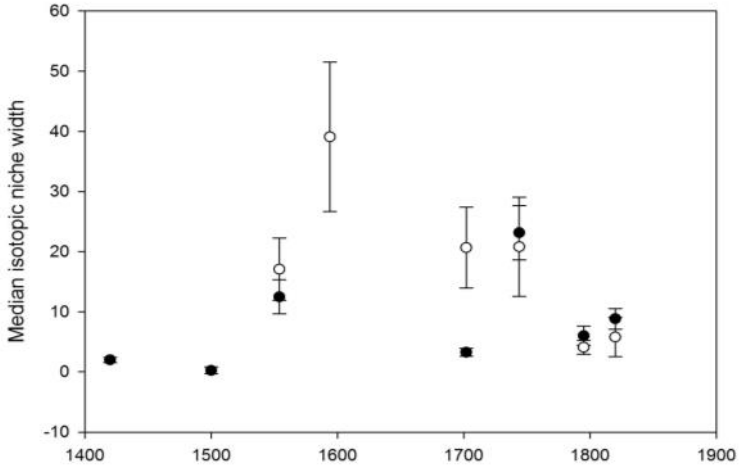
Multiple, large well dated archaeofauna are powerful tools.

Stable isotope values $\delta^{13}C$ and $\delta^{15}N$



Stable isotope values of Atlantic cod and seabird bones from the same excavations show a peak in $\delta^{13}C$ values (left) and increased niche width (below) for both species in the 16th century.

Collectively the results signal a disruption in the North Atlantic marine ecosystem coinciding with a temperature minimum (GRIP ice core).



PROCEEDINGS OF THE ROYAL SOCIETY B

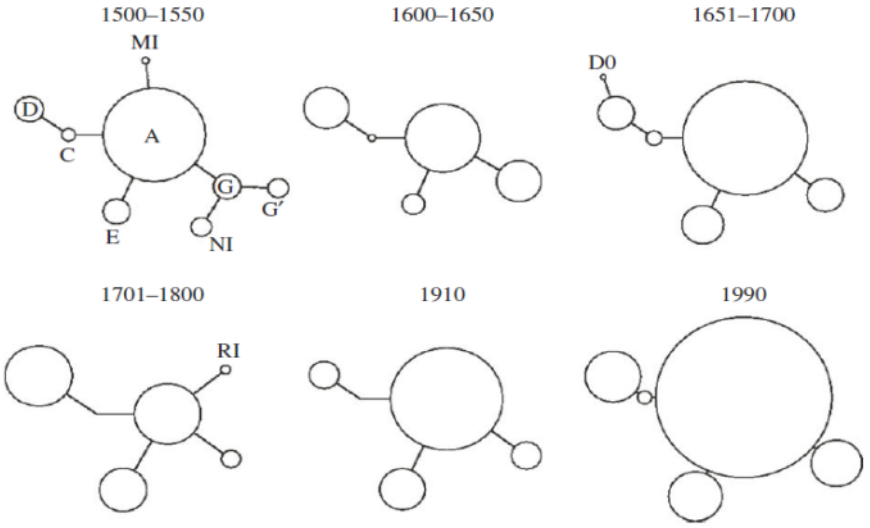
rspb.royalsocietypublishing.org

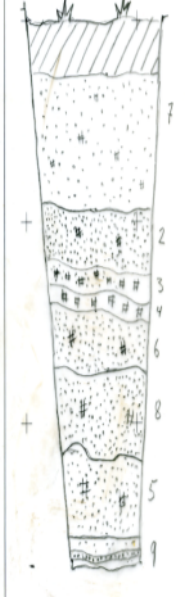
Research

Historical DNA reveals the demographic history of Atlantic cod (*Gadus morhua*) in medieval and early modern Iceland

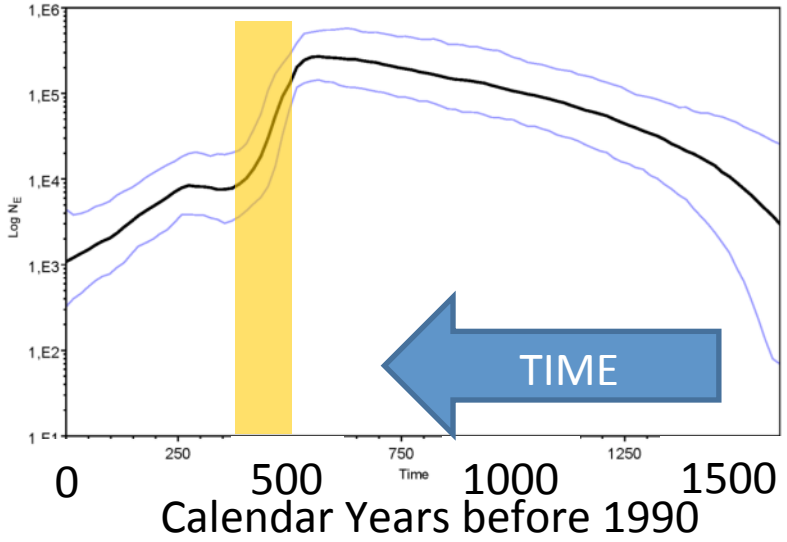
Guðbjörg Ásta Ólafsdóttir[1], Kristen M. Westfall[2], Ragnar Edvardsson[1] and Snæbjörn Pálsson[3]

[1]Research Centre of the Westfjords, University of Iceland, Adalstraeti 21, IS415 Bolungarvik, Iceland
[2]VÖR Marine Research Centre, Nordurtangi, IS355 Snæfellsbær, Iceland
[3]Department of Environmental and Life Science, University of Iceland, Sturlugata 7, IS101 Reykjavik, Iceland



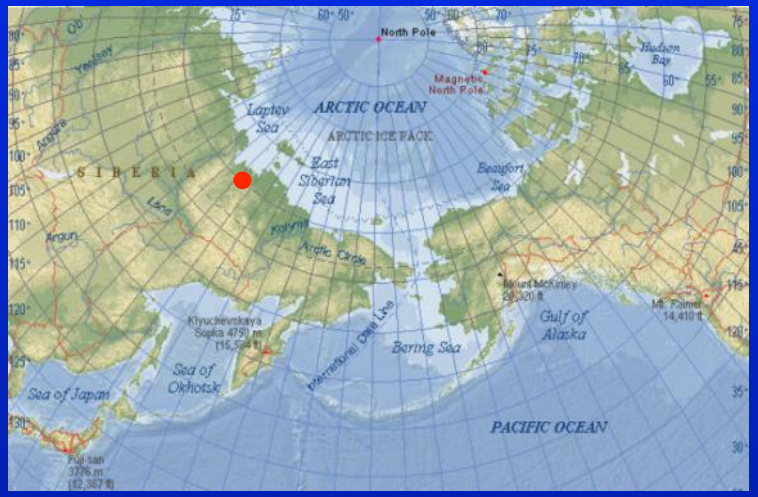


aDNA was extracted from Atlantic cod vertebrae (n=159) excavated at coastal sites in western Iceland. Sequences of the mitochondrial gene cytB signal the loss of haplotypic variation in the 16th century (above) indicating a significant reduction in Atlantic cod population size (right).



Yana RH Site : 28,000

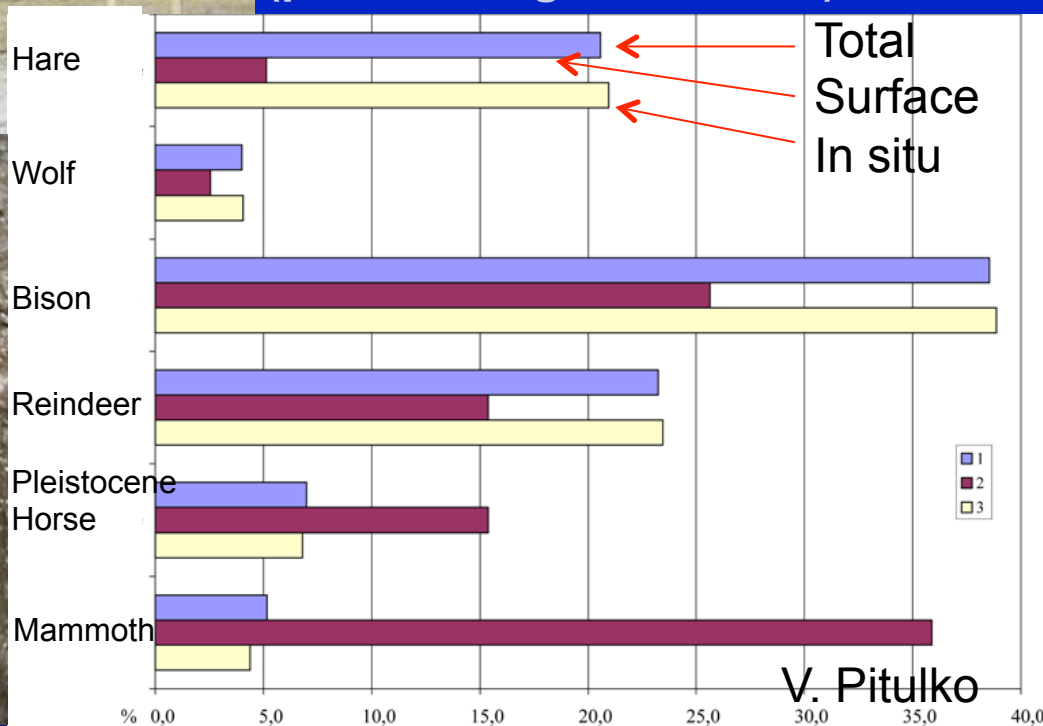
The oldest archaeological site in the true Arctic!
Same age as Chauvez Cave in France.
Yana is at 71 degrees N.



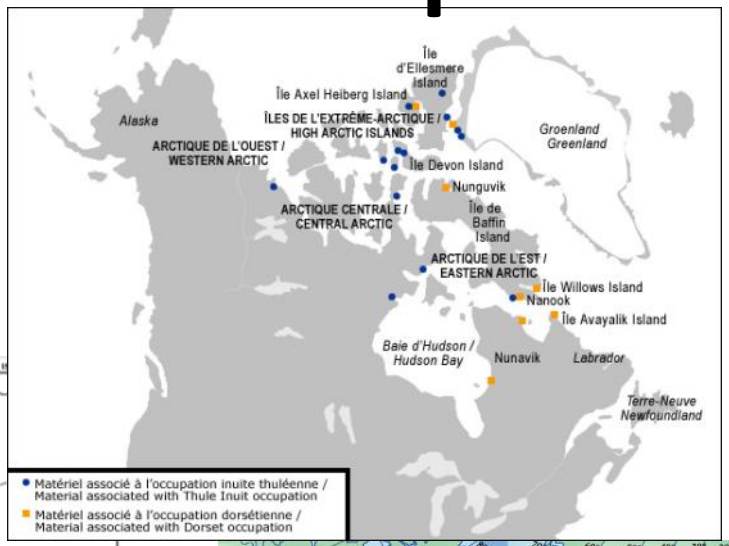
Decorated diadems, bracelets, needles, awl, and needle cases. Needle cases are of wolf long bone, others are mammoth ivory. Needles have property marks on them.

28,000 Year old Yana RHS site (N.Siberia) (V. Pitulko)

Remarkable site includes fauna from hunting at the end of the last Interstadial period. (paleoecological archive)



Linking Archaeological Sites into Long-Term **Spatio-Temporal Networks**



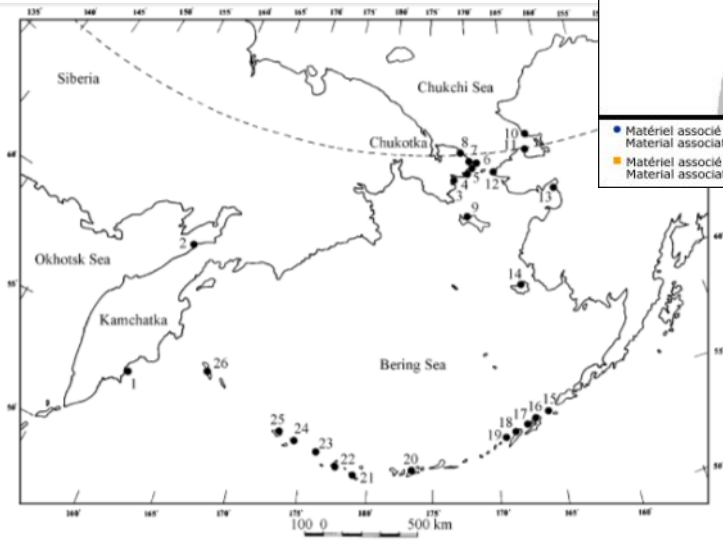
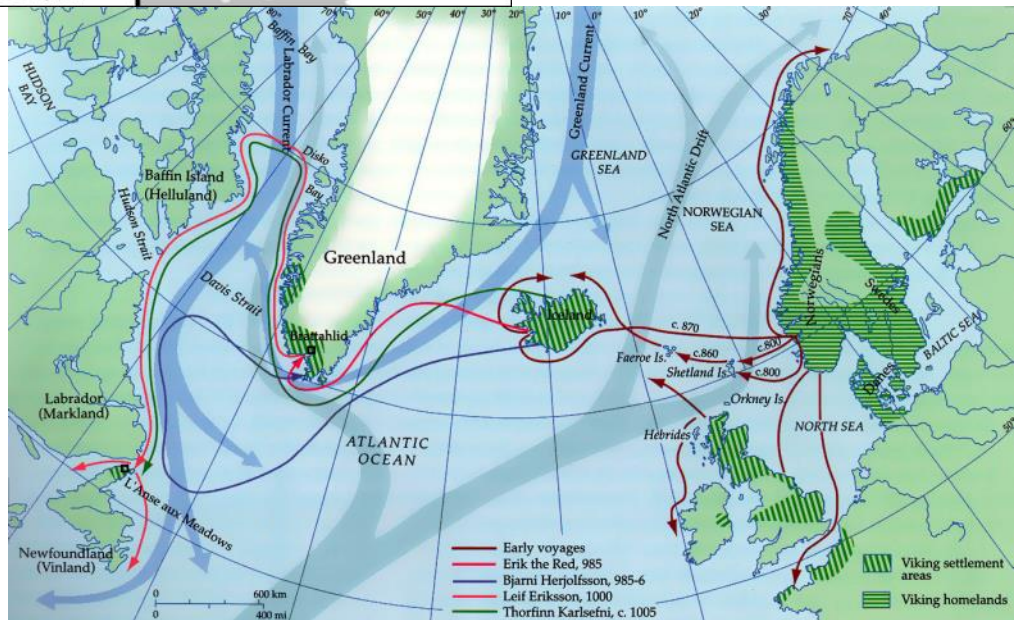


Fig. 1. Site location map: 1—Zhupanovo, 2—Galgan, 3—Masik, 4—Yandogai, Pinakul, Nunyamo, 5—Leimin, Tunytlin, Eilekei, Ekven, Nynluvak, 6—Dezhnevo, Naukan, 7—Uelen peat deposit, 8—Chigetun, 9—St. Lawrence archeological sites, Naskak peat deposit, 10—Cape Krusenstern, 11—Cape Espenberg, 12—Cape Prince of Wales, 13—Cape Denbigh, 14—Nunivak Is., 15—Akun Is., 16—Unalaska Is., 17—Amaknak Is., 18—Umnak Is. (Chaluka, Sheep-Creek, Oglodax'), 19—Anangula Is., 20—Adak Is., 21—Amchitka Is., 22—L. Kiska Is., 23—Buldir Is., 24—Shemya Is., 25—Attu Is., 26—Bering Is.



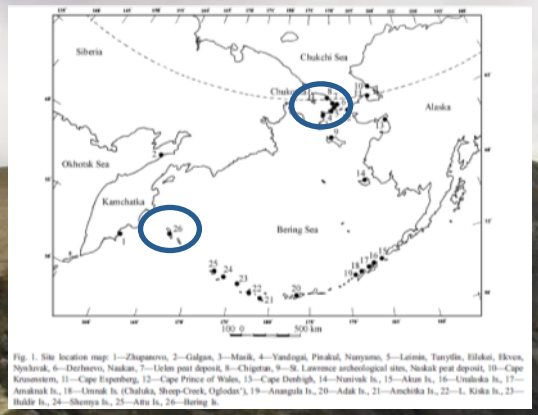


Fig. 1. Site location map. 1—Zhupanovo, 2—Galgan, 3—Masik, 4—Yandogai, Pinakul, Nunyamo, 5—Leimin, Tunyflin, Eilekai, Ekven, Nynkvak, 6—Dezhnevo, Naukan, 7—Uelen peat deposit, 8—Chigetan, 9—St. Lawrence archeological sites, Neskak peat deposit, 10—Cape Krusenstern, 11—Cape Espenberg, 12—Cape Prince of Wales, 13—Cape Denbigh, 14—Nunivak Is., 15—Akun Is., 16—Unalaska Is., 17—Amaknak Is., 18—Umnak Is. (Chaluka, Sheep-Creek, Oglodax'), 19—Anangula Is., 20—Adak Is., 21—Amchitka Is., 22—I. Kiska Is., 23—Buldir Is., 24—Shemya Is., 25—Attu Is., 26—Bering Is.

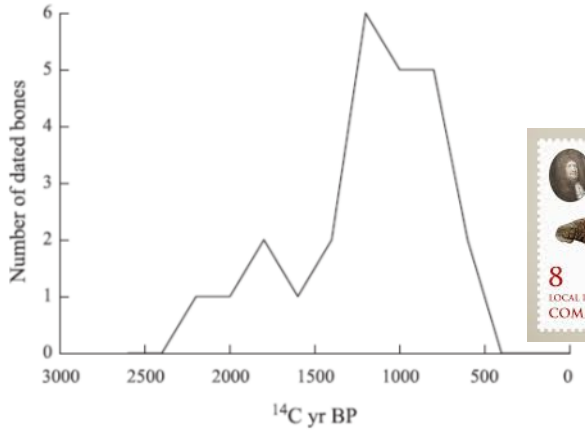


Fig. 3. Steller's sea cow population according to radiocarbon dates of bones from Bering Island (Commandor Islands).

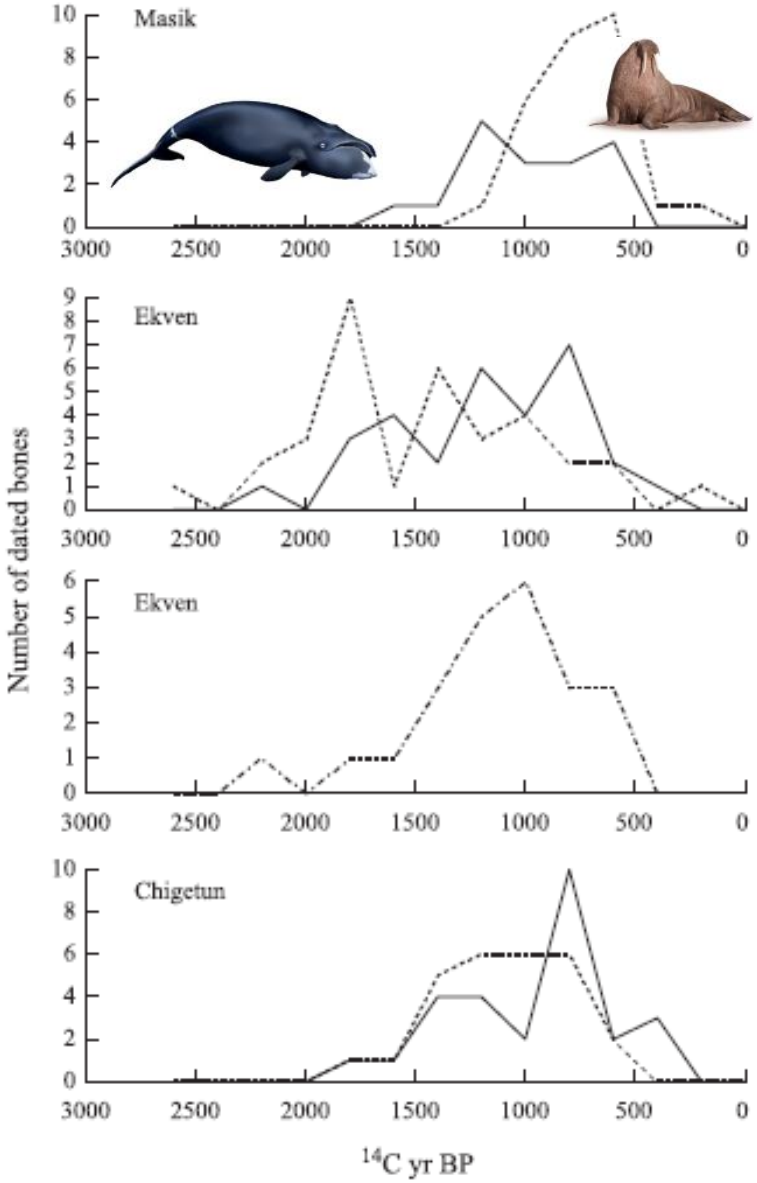
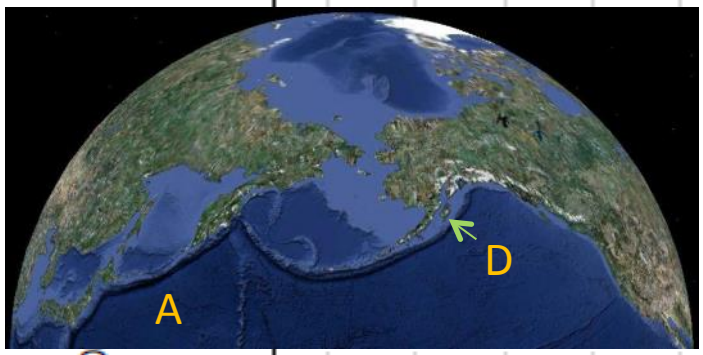


Fig. 2. Reconstructed history of catch of bowhead (solid line), gray whale (dotted line) and walrus (dot and dash line) according to radiocarbon dates of bones from ancient sites in Chukotka.

Savinetsky *et al. 2004. Palaeogeography, Palaeoclimatology, Palaeoecology 209 (2004) 335– 352*

Human population change suggests possible spatio-temporal, ecological asymmetry



calibration uncertainty

Exploratory "tight" KDE

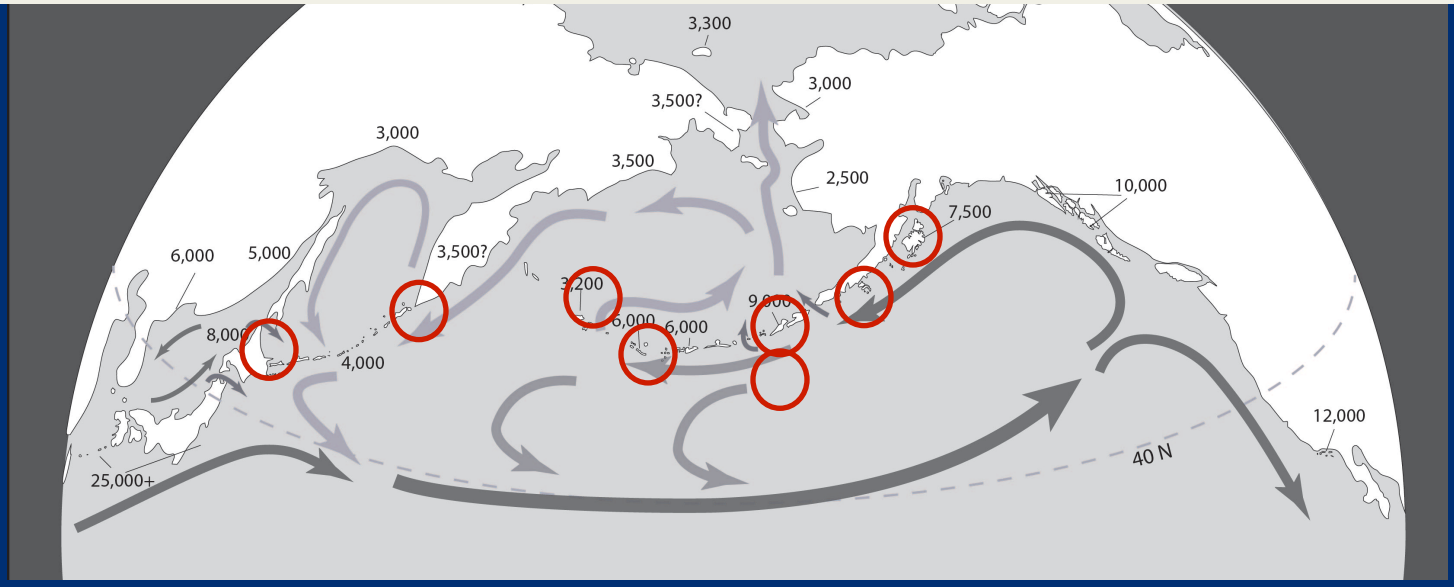
D. Kodiak Islands

A. Kuril Islands

Why are Kodiak and Kuril curves in almost opposite phase for the past 1500 years?

Methods

- Relative Abundance
  (e.g., sea mammals vs. bottom fish)
- Isotopes $\delta^{15}N$, $\delta^{15}C$ (feeding ecology)
- aDNA – (population bottlenecks)



Concluding Points

- Archaeological sites can contribute important data on long-term trends in marine (and terrestrial) ecosystems as well as the human engagement with those systems.
- These data allow access to time scales of environmental change that exceed that of instrumental observation data.
- We are starting to be able to use these data comparatively across space to construct truly regional pictures.
- Unfortunately, climate change is destroying many of these sites/archives. This is a crisis in the Arctic, especially. See Anne Jensen's talk this afternoon in the Human Dimensions session (Steel at 3pm)