A Probabilistic Approach to Constructing Networks in the Kuril Islands

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April 12, 2018

83\textsuperscript{rd} Annual Meeting of the SAA, Washington, DC
One of the persisting challenges for generating archaeological network narratives is understanding the change in networks over time.

**Epi-Jomon**
(2600-1300 cal BP)

**Okhotsk**
(1300-700 cal BP)

Gjesfjeld 2014
A probabilistic approach to networks

- Build networks at fine-grained temporal intervals by aggregating probability distributions of radiocarbon dates
- Weight edges of networks using non-temporal metric (distance)

<table>
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<th>Benefits</th>
<th>Drawbacks</th>
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<td>• Longitudinal perspective</td>
<td>• Simplifying assumptions</td>
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<td>• Alternative if limited by the archaeological record</td>
<td>• Bias in radiocarbon record</td>
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KBP-IKIP Radiocarbon Database

380 radiocarbon dates from the Kuril Islands, NE Asia
• 57 different archaeological sites (8 intensively dated sites)

Fitzhugh et al. 2016
Kuril Paleo-Population Estimate

Fitzhugh et al. 2016
1) Estimate probability of occupation at each site at every 5-year temporal interval

*Assumption that when probability of site occupation is 0, no occupation occurs (i.e. absence of evidence = evidence of absence)
2) Estimate the probability of simultaneous site occupation for all pairs of sites (dyads) at each temporal interval

- Use only sites with 3 or more radiocarbon dates
- 32 sites, 330 dates
- A network of 496 dyads with probabilities calculated at each of the 1200 temporal intervals
- Contemporaneous site occupation (CSO) network
Constructing a probabilistic network

3) Build network with edges weighted by geographic distance (or whatever external measurement is used)
   • Weibull survival function ($\lambda = 5, \kappa = 0.5$)
Constructing a probabilistic network

4) Multiple distance-weighted (DW) network by the contemporaneous site occupation (CSO) network for each time interval

The DW-CSO network represents an estimate for the maximum network size at each time interval
Change in DW-CSO Network through time

- Every fifth network sampled
  - 25-year intervals
- Estimated network size for DW-CSO

- 4000 - 0 cal BP
- Epi-Jomon (2600-1300)
- Okhotsk (1300-700)
Interpreting probabilistic networks

How does the mean interaction distance of networks change over time? (Average geographic distance of network ties)
Interpreting probabilistic networks

How does the mean interaction distance of networks change over time? (Average geographic distance of network ties)

- Decline of interaction distance through period
- Sites are becoming more spatially clustered
What might this suggest about the archaeology of the Kuril Islands?

• Maintaining long-term, longer-distance connections can be difficult in remote and unpredictable environments

• Communities might be willing to pay the costs associated with longer-distance connections during colonization but less likely as time goes on
Network Narratives

• The strength of the network narrative is only as strong as the methods and assumptions used to construct the network model.

• There is no specific recipe for how to construct archaeological networks and we should feel free to explore how different sources of archaeological data and assumptions can inform our network narratives.
Acknowledgements

Special Thanks to:
Stefani Crabtree
Barbara Mills

Kuril Biocomplexity Project
International Kuril Islands Project

Thanks!