SETTLEMENT

Teacher's Manual

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Subjects:

History, Geography, Science, Social Studies

Duration:

Two class periods

Class size:

10 - 30

Overview:

In this module, students will be introduced to statistical distributions to address questions about historical changes in human settlement patterns and to raise questions about the causes of these changes. Through an exercise designed to engage students in statistical data manipulation, they will learn how archaeologists use radiocarbon-dated settlements to reconstruct changes in the intensity of occupation in different locations. They will then compare these patterns to explore changes in settlement over time and space. The final component of this module gives students a chance to think about possible causes of historical changes in settlement distributions through correlation with environmental phenomena such as volcanic eruptions. Exercises engage students in quantitative and basic descriptive statistical manipulations (data aggregation and histogram construction) and in hypothesis formation and testing. The exercise is designed to convey the important realization that human settlement is not static but changes, sometimes dramatically, over time.

Goals:

- To teach students how archaeologists interpret settlement history based on site distributions and radiocarbon dates, and how they seek to explain change through analysis of correlations with environmental phenomena and changes in culture.
- To engage students in the analysis and interpretation of distribution data.
- To engage students in interpretations about human-environment interactions.
- To engage students in integrative/ systemic thinking exercises.

Objectives:

1. Students will learn how to observe changing frequencies of dated archaeological settlements by organizing data into histogram form and how differing the intervals ("bins") of a histogram can change the graphical representations. This is a basic aspect of scientific data analysis and a descriptive statistical procedure.

2. Students will learn to compare proxy data for environmental events and human settlement and to develop and evaluate hypotheses about the causes of human settlement change. Correlation is a basic aspect of scientific reasoning. Students will also learn to critically examine the methods used and the strength of conclusions.

Material Included in the Box:

A PowerPoint slide show (with a narrative script for the teacher)

Handouts with real radiocarbon data from a segment of the Kuril chain, data on historic catastrophic events (tsunamis and volcanic eruptions), and a climatic reconstruction.

Vocabulary

Deposit:

Sediment laid down on the earth's surface in the past, either by natural or human action. Archaeological deposits were created by people in the past and can include soil, artifacts, structures, or other traces of human activity that signal anthropogenic (human) involvement in the deposition process. Individual deposits usually form horizontal layers or "strata" that stack up over time like a layer cake, with the oldest at the bottom and the youngest at the top. Consequently, the oldest archaeological deposits (or geological deposits, for example volcanic ash layers) are found below younger ones, allowing us to develop histories of events by studying the stratigraphy. However, material within deposits can be out of place for a number of reasons (for example, through disturbance by burrowing animals), leading to possible misinterpretations of the stratigraphy of a disturbed site or excavation. (See Stratigraphy module.)

Distribution:

An arrangement of observations or values according to some variable(s). For example, a geographical distribution might refer to the location of settlements in space, according to their latitude and longitude coordinates (the variables), whereas a stylistic distribution might refer to the frequency of pottery specimens according to designs on them (the variables).

Histogram:

A graph which visually represents the distribution of data by showing the frequency of data points lying between two values along a variable axis, i.e. within a specific "bin." The distance between these two values is referred to as the "bin width." Histogram bins are usually of equal size.

Landscape:

In archaeological usage, a landscape is a geographical space larger than a single settlement across which people conduct their activities. This concept provides a framework for discussing the ways that past people have interacted with the environment and with each other at a broad scale, e.g. in their regular movements between settlements, hunting grounds, agricultural fields, institutional facilities, monuments, resource extraction locations, etc. Thus, cultural landscapes typically subsume multiple settlements, towns, and/or cities, as well as their hinterlands, within them. Over time, cultural landscapes change as human lifeways are reorganized, and untangling these changes based on archaeological evidence is an archaeological challenge.

Radiocarbon Date:

A numerical date which approximates the time of death of an organism (plant or animal) based on the amount of radioactive carbon that remains in it. Radiocarbon dates are often used by earth scientists and archaeologists to understand the timelines of geological or cultural events.

Settlement:

A location occupied by a group of people for some period of time. Settlements can be recognized by archaeologists by the cultural remains left behind at such locations, such as artifacts (stone tools, pottery, etc.) and features (remains of house structures or depressions, hearths, etc.), as well as by changes in the composition of local vegetation (human activities often enrich soils, encouraging lush vegetation growth).

Settlement Pattern:

The geographic distribution of settlements during a specific time period. Studying settlement patterns reveals information about initial colonization of areas by people and eventual changes in their habitation and/or resource use.

Site:

A location in space. This term is used by researchers to refer to a location where data have been collected. In archaeology this term has a more specific meaning, refering to a location where archaeological materials/deposits are found in great concentration, typically surrounded by areas exhibiting little or no archaeological material. Often, archaeological sites are the remains of settlements, though alternatively some were created by other kinds of human activity.

Years BP (years before present):

The amount of time which has passed between the occurrence of an event and the year A.D. 1950. To prevent confusion, radiocarbon scientists defined A.D. 1950 as the 'present' so that radiocarbon ages always refer back to this same fixed point in time. For example, 537 years BP will always refer to the year which preceded A.D. 1950 by 537 years, in other words A.D. 1413.

Background Information

Archaeologists seek to understand how people lived in the past based on the material remains people left behind, in the form of artifacts, features (e.g., house storage pits, house structures, and sometimes monumental buildings), and other traces of their activities (e.g., transformed soils, chemical stains). Some archaeological questions require the analysis of the distribution of artifacts, soil deposits, and features at specific locations called "sites," but an important part of archaeology also asks questions about changes at the broader scale of cultural landscapes. The analysis of settlement distributions across landscapes is called "settlement pattern analysis." Archaeologists use this approach to discover where people lived at different times in the past. Archaeologists generate this kind of understanding through survey, the process of looking for archaeological sites across vast areas of land.

The Kuril Biocomplexity Project surveyed the entire Kuril Archipelago between 2006 and 2008, finding a total of 68 different archaeological sites, distributed from the southern island of Kunashir to the northernmost island of Shumshu. These sites can be presented on a map showing their distribution throughout the islands. By itself this information indicates that people have lived throughout the island chain, but it does not tell us anything about how they came to live there or when, whether or not colonization occurred in a single event or multiple times, from which direction people came, or who they were.

To put archaeological settlement distributions into a historical framework, archaeologists need to assign ages to site occupations. One of the most common ways to do this today is to find organic material in the archaeological deposit (such as wood, charcoal, bone, seeds, or textiles) and submit this to a special laboratory for radiocarbon dating (see Chronology module). If the site has a deep archaeological deposit comprising multiple archaeological layers, it is important to collect several dates from different layers or depths. If the site covers a large area, it is also important to collect dates from across the site. These dates then help the archaeologist determine the history of occupation at the site and ultimately how the site formed. Combining dates from many sites provides critical information for building a picture of changes in the distribution of populations across space. This is often done by building histograms, which describe the changing frequency of settlements over time, per some standard interval (commonly labeled a "bin," e.g., per 200-year interval). As forms of statistical description, such histograms are convenient tools for looking at changes in the frequency of archaeological materials deposited over time. However, archaeologists also need to think carefully about a number of factors that can bias the pattern observed in such histograms. For example, we don't want our results to be influenced by the possibility that some sites or regions have been studied more intensively than others. To avoid these problems, we often decide to include only one date per site per histogram bin, or only one date per portion of a site per bin. Doing so minimizes the possibility that we are dating multiple samples deposited by the same group of people – in other words, double-counting them – while counting other groups only once.

Lesson Plan

Activity 1 (Day 1)

Students learn how archaeologists search for data that can be used to reconstruct settlement patterns in a region.

Warm Up:

Have students think back to earlier history lessons and compare a mobile and a sedentary way of life. What are the characteristics of each? (Example: size of groups, size and permanence of dwellings, amount of possessions, prevalence of communicable diseases, etc.)

Procedure:

1. Use the slideshow included to familiarize students with how archaeologists study settlement patterns in a region and how archaeologists worked in the Kuril Islands. The script attached to the slideshow has several questions that can be used to initiate discussion during the slideshow to make it more interactive. (slides 1-13).

2. Explain what histograms are (plots of changing frequency over time) and why they are a useful way of visualizing data.

3. To help students practice constructing and reading a histogram, use data from a few of the oldest sites in North America to (slides 14-19; the text under the slides in PowerPoint should help directing this activity). The first step in this exercise is to build a timeline (see the slides) as a reference, after which students can transition to constructing a histogram. Ask students to think about what the histogram indicates about the settlement or population of the region during the last 14,000 years.

Wrap up:

Ask students to name the steps in the process of settlement pattern research. They should come up with the following six steps based on the PowerPoint:

- Locate archaeological sites, test them, and collect organic materials from their archaeological contexts suitable for radiocarbon analysis (see the Chronology module).

- Submit these samples to a professional lab to get radiocarbon age determinations.

- Organize the radiocarbon data and create histograms based on them.

- Compare changes in frequency through time, between different regions, and with other information (e.g., environmental histories).

- Formulate hypotheses to account for the patterns observed through comparison.

- Evaluate these hypotheses with additional evidence (tip: students might not think of this, ask them to think about how science works - progressively, constantly testing what has been discovered).

Activity 2 (Day 2)

Students use real data from the Kuril Islands to reconstruct population history of the chain during the last 4,000 years and try to draw links between catastrophic natural events and settlement history of the islands.

Warm Up:

Review material from the previous day. Discuss what natural hazards could influence whether people stay on or abandon an island or the chain. Have students remember the 6 steps of the settlement pattern research (see above).

Procedure:

1. Show the class the map (slide 20) of the location which they will be investigating in the exercise.
2. Hand out the data for the exercise (radiocarbon dates and ages of catastrophic events plus the templates for histogram plotting) and a worksheet with questions about the data. You may chose to divide students into groups which focus on the same island and construct histograms using 3 different bin sizes to consider how the bin size can influence the conclusions. Alternatively, groups can work using the same bin size and compare the three islands. You could also have some groups work on the first option and some – on the second.
3. Students work in small groups to construct the histograms and answer related questions.

Conclusion:

Discuss as the whole class what the data tells you about the occupation on each island and in the region in general. Discuss the possible causal links with the catastrophic events. Ask students to brainstorm about what might be additional evidence that people were influenced by these events? For example, what kind of features would indicate that people abandoned an island after a volcanic eruption? (Possible answers: abrupt change in stratigraphy to ash or a lava flow with a gap in occupation.)

Wrap Up:

There are many complications that make using radiocarbon dates as indicators of population change less straightforward than we would like. To convey this point, have a discussion with class about what could make the interpretation of radiocarbon dates biased (i.e. not reflective of reality). Here are potential answers:

- Due to a change in climate patterns, more large storms or tsunamis caused more erosion following some period of settlement and differentially eliminated sites of that period.
- Sites in some area got buried under volcanic deposits and are too deep to be discovered by the archaeologists digging shovel tests.
- Archaeologists sampled sites in a biased way, for example they only looked at the coastal areas, but not in the inland parts of the islands, where people lived during some time. In that time period, population estimates would be much lower, because archaeologists missed those sites.
- Archaeologists collected more samples from certain kinds of sites or worked only in regions that are easier access (closer to roads, etc.).
- Using data from several different projects to reconstruct population adds potential difficulties, because different projects may have had different focus or different funding possibilities (some sites or areas were perhaps more intensely surveyed and dated than others).

To use radiocarbon dates as indicators of past population change, archaeologists have to rule out these factors to the best of their abilities.

Student Worksheet guide

Plotting Date Distributions

Exercise Introduction

Archaeologists sometimes estimate the history of human settlement across a region by comparing the relative frequencies of **radiocarbon dates** from different site locations.

To do this, the first step is to generate a large set of **samples** for dating. This is done by finding sites through **survey**, excavating test pits and collecting charcoal, bone, and other organic materials from within archaeological **strata** or **deposits**.

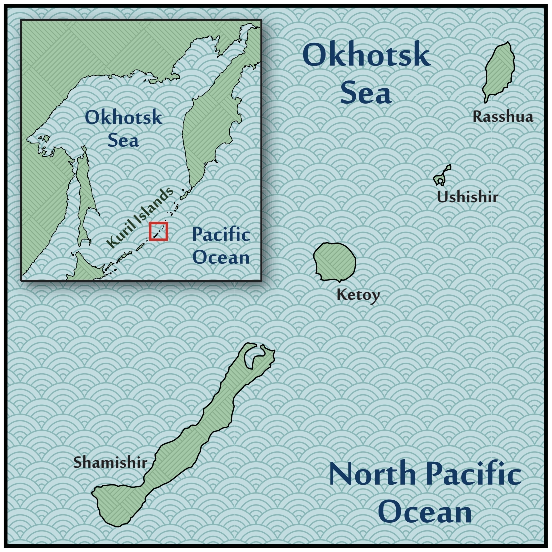
The next step is to submit as many of these samples as possible to a radiocarbon lab, which specializes in measuring the ages of the samples based on the amount of radiocarbon contained in them. While radiocarbon dating is expensive (between \$300 and \$600 per sample), having a large number of dates is important to get a clear picture of past history. The samples submitted should be randomly selected from the total to make sure that the results do not over-emphasize just one kind of site or time period.

When the lab sends back the results, the third step is to count the number of dates per time period and to look at changes through time. If a larger number of dates occurs in one time period than in another, this might tell us that more people lived in the region during that period.

The fourth step is to try to explain changes observed in the number of dates over time.

In this exercise, you will practice the third and fourth steps of this process, using actual data from the Kuril Islands.

During the Kuril Biocomplexity Project, archaeologists worked in the segment of the island chain shown on this map.



Step 1:

Using survey techniques, archaeologists found prehistoric human settlements, which they tested to find datable materials. They then submitted organics like wood and charcoal to radiocarbon labs to be dated, to find out when each island was occupied. The attached table of radiocarbon dates shows the results of these tests. To tell whether there were significant changes in the populations of different islands (including the abandonment of some islands), your task is to compare changes in the frequencies of dates from each island. To do this, you will construct histograms from radiocarbon dates. Histograms are graphs which plot the frequency (quantity or number) of observations occuring within a sequence of intervals or "bins." Different histograms have bins of different sizes, called "bin widths" (e.g., 100, 200, or 400 years per interval). Histograms of radiocarbon dates provide a convenient way to look at changes in population size through time.

Plot the number of dates on the graphs provided, grouping them into sets per time interval (bin). Your teacher will indicate whether you will plot dates using the same interval on all three islands or take one island and use three different bin sizes for the dates from that island.

For example, if you are using bins having 100-year bin widths, you would count the number of dated samples that fall between 1,600 and 1,699 years BP (before present), then 1,700 to 1,799 years BP, and so on. If you have counted eight samples falling between 1,600 and 1,699 years BP, you would then shade in a bar that is eight units high in the column between 1,600 and 1,700 years BP. Follow the same procedure for all intervals.

After completing these histograms, answer the following questions:

Question 1:

a. How similar are the occupation histories of the different islands to each other?

b. Does it look like people lived in all three regions at the same time?

c. Did they leave all three regions at the same time?

Answer:

The occupation histories for each island are somewhat different, but agree in many respects. Simushir has two modes (peaks) between 800 and 1,299 BP and between 1,500 and 1,999 BP. These modes are matched in the Rasshua distributions, suggesting that people inhabited and left both islands at the same times. Even so, the older mode on Rasshua extends back to 2,699 BP, if we ignore small gaps that might be sampling errors. One could say that the earlier start indicated in the Rasshua histogram represents an earlier colonization there, eventually expanding to Simushir. In fact, this is more likely a sampling problem, since Simushir was more likely on the migration route to Rasshua than vice versa and would thus have been colonized first.

The Ushishir sample is too small and the resulting histogram is not reliable on its own, at any bin width.

Question 2:

If the histograms differ by region, are the patterns complementary? That is, might people have abandoned one island in favor of one of the other two?

Answer:

As noted above, the Simushir and Rasshua distributions suggest a possible earlier occupation of Rasshua, with later movement to Simushir. Both islands appear to have been abandoned at about 1,600 BP, then recolonized, then once again abandoned at about 800 BP.

Step 2:

Now you are going to compare your population histories with information about environmental impacts and changes, to see if you can explain why settlement patterns changed over time.

When archaeologists were looking for the settlements left behind by the prehistoric inhabitants of the Kurils, geologists were researching the geological history of the islands, using radiocarbon dating and other methods to determined when the largest volcanic eruptions and tsunamis in the area occurred. Meanwhile, paleoclimatologists studied lake cores and other evidence to determine when the climate was wetter or drier, cooler or warmer, in the region.

Examine the results of their studies. Compare these results to the histograms you created. You might want to indicate on your histograms when these environmental events or changes occurred. This will help you to see the relationships between human populations and natural conditions. Then answer the following questions.

Question 3:

a. Do the patterns of population change correspond with catastrophic events recorded for the region? For example, can you justify assertions that volcanic eruptions, tsunamis, or climate changes forced regional abandonment or movement of the population from one island to another?

b. How convincing do you find your conclusions to be (how well do the patterns match up)?

Answer:

3a: Climate changes appear to happen both during and between occupations, rarely corresponding with times of transition in our population data. Volcanic eruptions are only slightly more interesting, as follows:

The most recent eruption of the Simushir volcano (Zavaritsky 1) at 1,000 BP could have caused decline in population there, leading to abandonment 200 years later. On Ushisir, there is no strong case to be made for an impact, but the archaeological sample is too small to conclude one way or the other. Students are likely to think the gap from 1,000 to 800/700 years BP is meaningful. It could be, but the conclusion is not statistically justified. On Rasshhua, located two islands (or about 40 km) north of the eruption, no negative impact on populations is observed. Conversely, the data are consistent with the suggestion that people from Simushir and Ushishir moved away in response to the eruption, leading to an increase in population on Rasshua after 1,000 BP.

The massive caldera-forming eruption of Ushishir 2,000 years ago destroyed any evidence of prior occupation on that island and may have made it uninhabitable for the next 600 or more years. The archaeological record of northern Simushir starts more or less right after this eruption, and it is possible that the event forced people to move to this location from Ushishir island. Contradicting this hypothesis, however, is the evidence that Rasshua populations did not react. This is especially surprising because the Ushishir eruption caused an ash cloud that moved north and dropped as much as half a meter of volcanic ash on the largest human settlement on Rasshua. People must have temporarily left, but they came right back and carried on as if nothing had changed!

The two older eruptions of 2,400 and 2,600 years ago can only be compared to the Rasshua data. As with the other events, these eruptions appear to have had no impact on the settlement of these islands. People were already inhabiting Rasshua when these eruptions occurred, and population estimates indicate no negative change following these events. This is not unexpected for the 2,400 BP eruption, which occurred hundreds of kilometers to the south. Conversely, the 2,600 BP eruption on the island immediately to the north of Rasshua and could have forced people to migrate from that island toward their neighbors on Rasshua.

As for the tsunami evidence, one could argue that tsunamis played a role in instigating new settlements (e.g., around 2,900/2,750; 1,250; and 400 BP) and that they played a role in the ending of settlements (1,600/1,500 and 700/800 BP). However, tsunamis also occured in the middle of the periods of occupation (900 BP). We thus get a mixed picture in which tsunamis either appear to be really important or to have had no effect at all. What do students think?

Climate also appears to be poorly correlated with settlement or abandonment. The modes of population density occur both during cold and warm intervals.

From these various comparisons, we might conclude that catastrophic natural events and climatic phases had minimal influence on the settlement of these islands. This is in fact what our research in the Kurils has indicated. Yet, if natural events and changes were of minor importance, this leaves open the question about why people came and left the islands. While these factors were less important than we originally suspected, we still think they could have played an indirect role in human history there, for example by amplifying the adverse effects of other stresses such as the loss of preferred food sources or the disruption of trade networks. At the individual level, the impact of tsunamis or volcanic eruptions can be huge, swaying individuals' decisions about whether to stay put or to leave, even if the larger population does not change much.

Step 3:

Step back and look critically at the analyses you conducted. Do you think there may be problems with the way this analysis was done?

Question 4:

a. Are there problems with the datasets used in your analysis, and what steps could be taken to reduce these problems, if any?

b. What assumptions support this analysis (list several)? For example, what must we assume to treat a single radiocarbon date as an indication of a unit of population (number of people)?

c. Are there problems with these assumptions?

d. How convincing are the correlations between settlement changes and environmental effects?

Answer:

a. Problems: 1. Small sample sizes (especially for Ushishir) limit the reliability of the histograms. Wider bin widths increase the robustness of the analysis but at the cost of precision. Solving this problem requires the collection of more data. 2. Interpreting these results in terms of human history requires that we accept several assumptions which may not be correct (see below).

b. and c. Assumptions: 1. The radiocarbon sample was collected in an unbiased way. 2. The charcoal record itself was not biased by natural filters (e.g., loss of large numbers of sites from a specific time period due to abrupt sea level change and erosion). 3. The samples that were dated were randomly selected, so that we don't have a disproportionate number of dates from one site or from the deepest or shallowest parts of sites. For example, archaeologists often date the oldest (lowest) layers of sites because they are interested in discovering when people first inhabited a location. If too many of these "basal" dates are counted, it could make the earlier populations appear large compared to more recent times. 4. There is no appreciable difference between target and dated events (see the Chronology module for an explanation of this assumption).

e. Correlations: The correlations between settlement and environmental information are quite weak. Rather, they provide evidence supporting a lack of causal relationship between natural conditions and population dynamics. However, for the purposes of this question, we should also note that the environmental data are of fairly low resolution, as are the settlement data. Attempting to match them in time is problematic because the precision on any of these dates is about ± 100 years. A tsunami could appear to have occured in the middle of two-century period of stable occupation but in fact could have occured right at the start or end of this period.

Student Worksheet guide

Plotting Date Distributions

Material - Question 1

Simushir

Sample Number	^{14}C Age (years BP) reported with error term*
AA-44258	1003 ± 43
AA-44259	1121 ± 38
AA-44260	1164 ± 44
AA-44261	1011 ± 40
AA-44262	1818 ± 43
AA-44263	935 ± 42
AA-40944	1695 ± 36
AA-44264	1732 ± 43
AA-44265	897 ± 38
OS-59199	1940 ± 40
OS-59197	1600 ± 25
OS-59381	1090 ± 25
OS-59421	1300 ± 30
OS-59346	1740 ± 30
OS-59201	1650 ± 25
OS-59202	1260 ± 30
OS-59203	1700 ± 30
OS-59204	1820 ± 30
OS-67420	1800 ± 25
OS-67269	1470 ± 30
OS-67616	1100 ± 30
OS-67586	1690 ± 30
OS-67617	1570 ± 25
OS-67470	1930 ± 35
OS-67471	1280 ± 25
OS-67587	1850 ± 30
OS-67472	1930 ± 30
OS-67492	1650 ± 30
OS-67588	1100 ± 30

Ushishir

Sample Number	^{14}C Age (years BP) reported with error term
OS-59419	1130 ± 25
OS-67329	1390 ± 30
OS-59418	1090 ± 30
OS-80150	430 ± 25
OS-80149	615 ± 25
OS-59420	100 ± 25

Rasshua

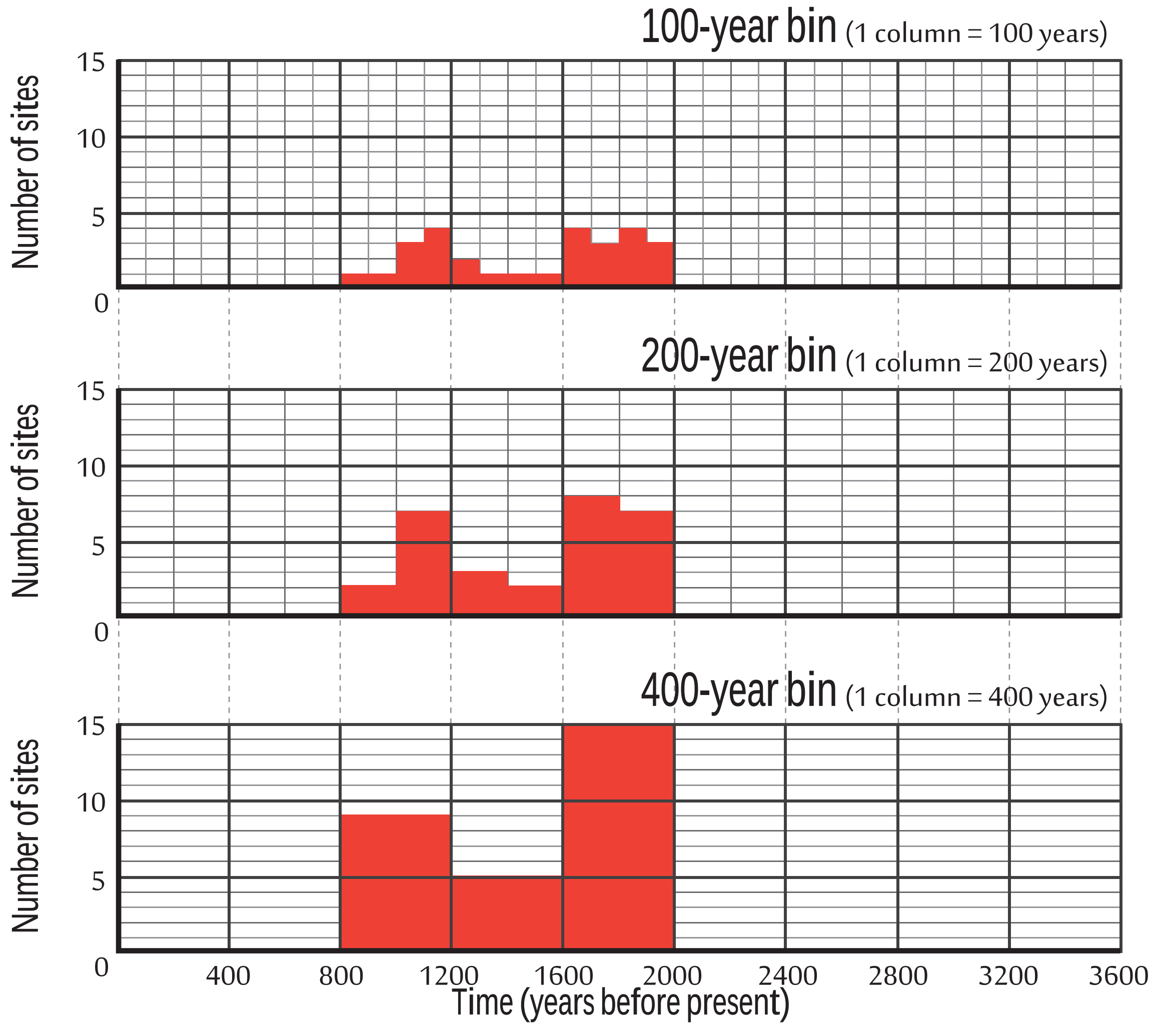
Sample Number	^{14}C Age (years BP) reported with error term
OS-67086	2430 ± 25
OS-67143	3260 ± 30
OS-67330	2570 ± 30
OS-67130	30 ± 30
OS-67131	1990 ± 30
OS-79721	905 ± 25
OS-79722	1000 ± 30
OS-79861	1860 ± 30
OS-79724	935 ± 25
OS-79726	950 ± 25
OS-79744	915 ± 30
OS-79863	2250 ± 25
OS-79864	2010 ± 30
OS-79862	1920 ± 25
OS-79727	245 ± 25
OS-79725	1820 ± 25
OS-79723	1100 ± 35
OS-79865	2020 ± 30
OS-79866	2040 ± 25
OS-79867	2040 ± 30
OS-79868	2160 ± 35
OS-79741	1700 ± 35
OS-79742	925 ± 30
OS-79743	3280 ± 35
OS-79728	315 ± 30
OS-79731	215 ± 25
OS-79730	205 ± 35
OS-79729	225 ± 30
OS-79896	2640 ± 30
OS-79600	1930 ± 25
OS-80139	1120 ± 50
OS-79601	1000 ± 25
OS-79602	3450 ± 30

Sample Number	^{14}C Age (years BP) reported with error term
OS-79603	1940 ± 30
OS-79594	1970 ± 30
OS-79595	1280 ± 25
OS-79596	905 ± 25
OS-79597	1970 ± 25
OS-79598	2260 ± 30
OS-79599	835 ± 30
OS-80015	1810 ± 25
OS-80016	1920 ± 30
OS-80017	2130 ± 25
OS-80018	2080 ± 25
OS-80019	1720 ± 25
OS-80020	1670 ± 30
OS-79668	1950 ± 25
OS-79669	2080 ± 25
OS-79670	2110 ± 25
OS-79671	2210 ± 25
OS-79720	2430 ± 25
OS-79665	2860 ± 25
OS-79666	2480 ± 35
OS-79667	2660 ± 25
OS-79604	2490 ± 25
OS-79664	170 ± 30
OS-79859	2230 ± 30
OS-79860	830 ± 25
OS-67133	130 ± 25
OS-67134	1720 ± 30
OS-67135	1100 ± 35
OS-67136	1190 ± 35

*see Chronology module for explanation of error terms

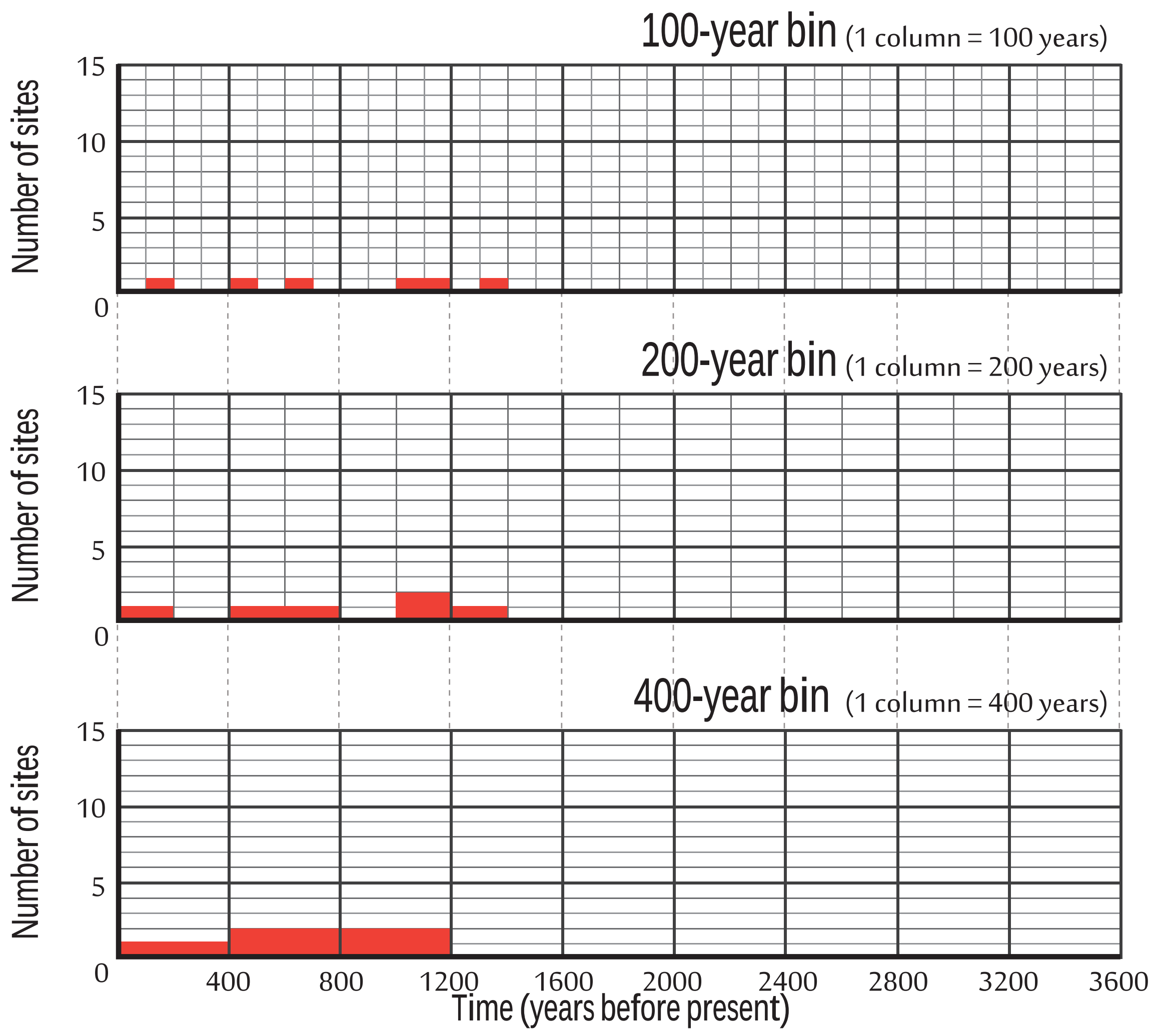
Simushir

Teacher background information: Histograms of radiocarbon dates from Simushir Island at 100, 200, and 400-year bin intervals for comparison.



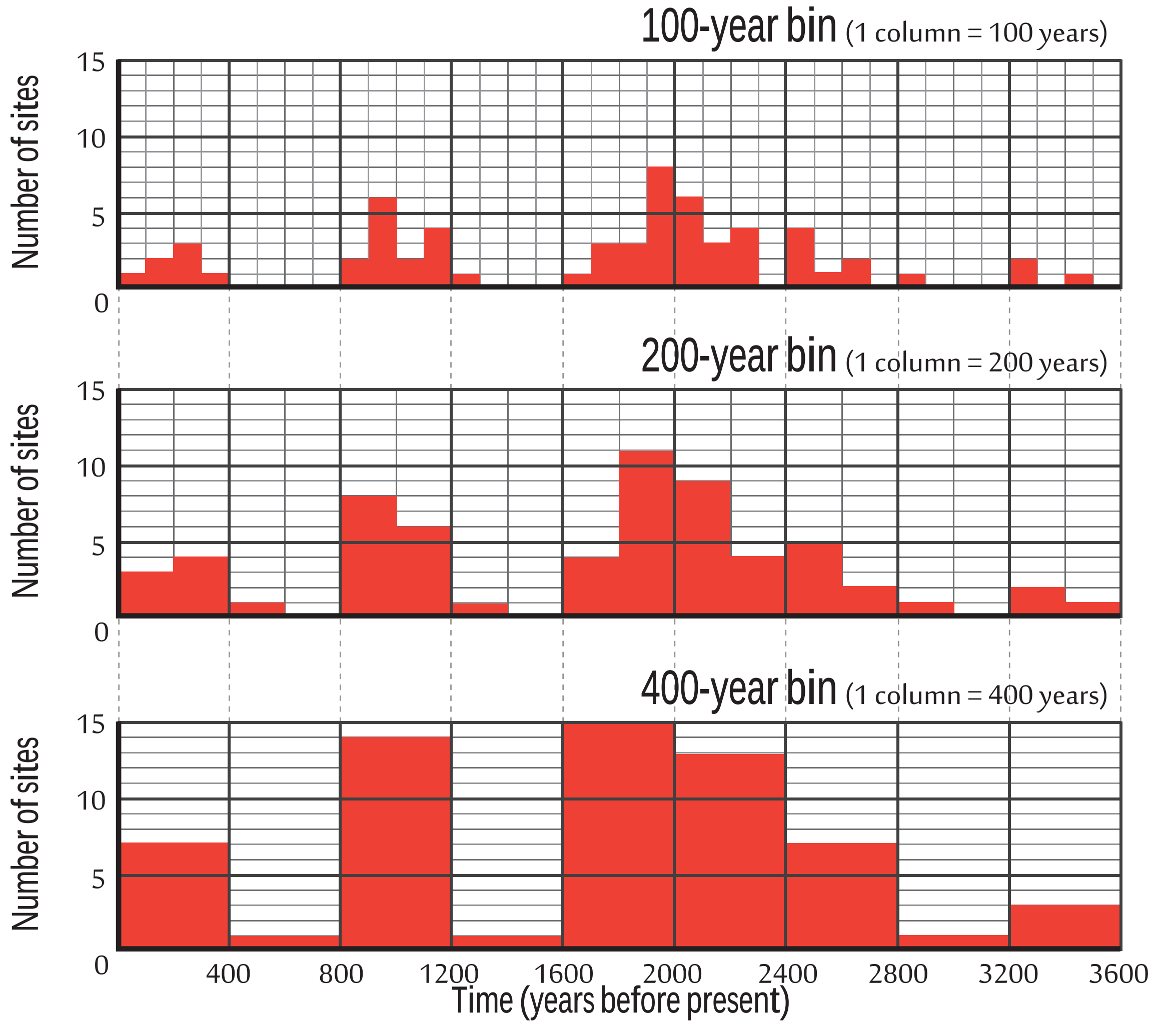
Ushishir

Teacher background information: Histograms of radiocarbon dates from the small Ushishir Islands at 100, 200, and 400 year bin intervals for comparison.



Rasshua:

Teacher background information: Histograms of radiocarbon dates from Rasshua Island at 100, 200, and 400 year bin intervals for comparison.



Student Worksheet guide

Plotting Date Distributions

Material - Question 3

Climate:

Age of Event	Notes
0-200 years BP	warm
200-700 years BP	cold/dry
700 - 1,100 years BP	warm
1,100-2,000 years BP	cold/dry
2,000-2,400 years BP	cooling

Climatic conditions (compared to presend) were determined using evidence such as pollen from lake cores (see paleoclimate module).

Eruptions:

Volcano	Island	Age of the Event
Zavaritsky 1	Simushir	1,000 years BP
Us-Kr	Ushishir	2,000 years BP
CKr	Iturup*	2,400 years BP
Sarychev	Matua **	2,600 years BP

Volcanic eruption ages were determined by dating tephras deposited by each eruption.

Notes:

*Iturup Island is over 200 km south of Simushir Island

**Matua Island is ~40 km north of Rasshua Island

Years BP: years before present ("present" refers to A.D.1950)

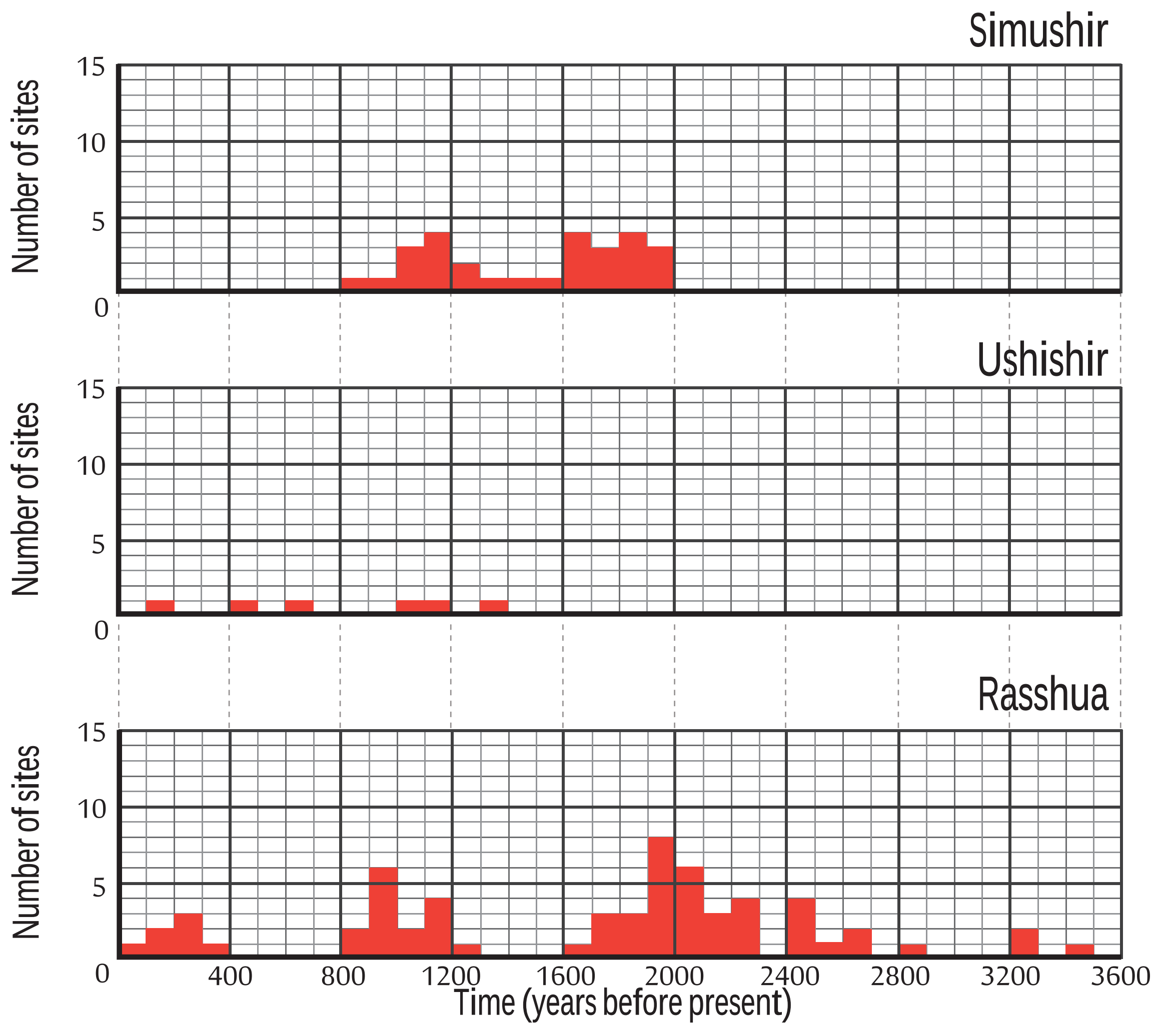
Tsunami:

Number	Age of the Event	Notes
1	100 years BP	
2	400 years BP	
3	700 years BP	
4	800 years BP	
5	900 years BP	
6	1,250 years BP	
7	1,500 years BP	
8	1,600 years BP	
9	2,750 years BP	(possibly)
10	2,900 years BP	(possibly)

Tsunami ages were determined by dating layers of beach sand deposited by large tsunami waves on the affected islands.

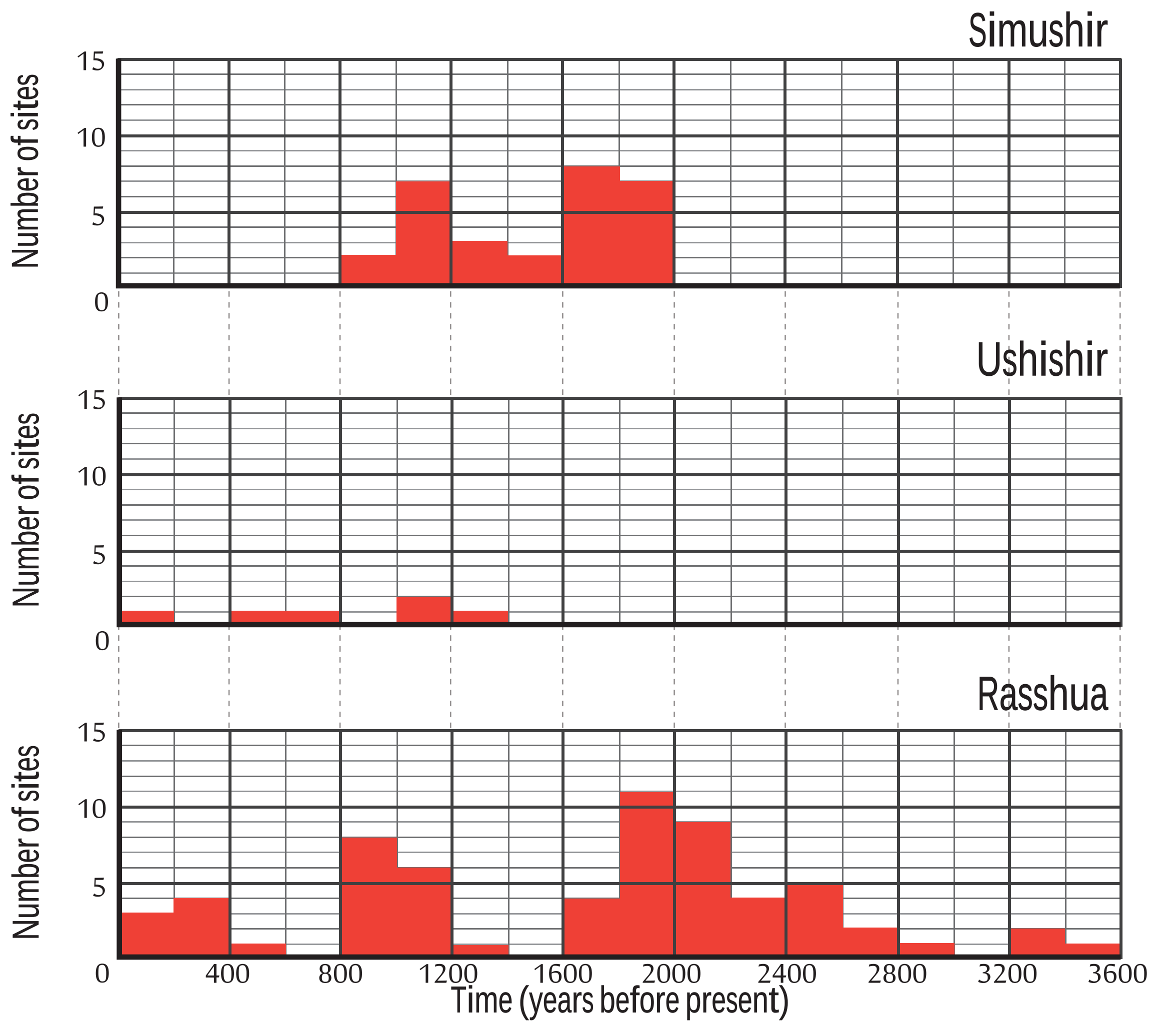
100-year interval

Teacher background information: Histograms of radiocarbon dates from all three islands using 100-year bin interval.



200-year interval

Teacher background information: Histograms of radiocarbon dates from all three islands using 200-year bin interval.



400-year interval

Teacher background information: Histograms of radiocarbon dates from all three islands using 400-year bin interval.