Biogeography Presentation Script

Hi all, I'm Spencer Furniss and the first research paper I will be talking about is entitled "The dispersal of alien species redefines biogeography in the Anthropocene." In case you don't know, the *Anthropocene* is simply the era of human existence. This paper explores the impact that human travel has had and will likely continue to have on the geographic distribution of species. As we have discussed in class, a species found in one region may live just as well in a more distant region but be absent there because it cannot survive crossing the intervening space on its own. The barrier may be a large body of water, land, region of inhospitable climate, or something else.However, the development of man-made vehicles that enable ever-increasing travel distances, speeds, and volumes has opened a new opportunity for many species to reach new locations where they can thrive.

*We might predict that prior to the advent of globalization, biodiversity of one specific region---for example, the Neotropical rainforests, where these monkeys live---would be more limited than in a more general region---for example, all tropical rainforests---and thatspecies in one region were most closely related to other species in the same or a nearby region. After human-mediated dispersal, these would be expected less and less, but we would also see climate become an even clearer factor in determining the maximum distribution of species.

*Altho we can see obvious, isolated examples of species successfully establishing populations in new locations with the same climate by means of human introduction, the authors of this paper researched in more detail the nature of this process on a global scale. * They did so by examining the changed species distributions of terrestrial *gastropods*, better known as snails and slugs,"because they are frequently introduced over long distances by means of trade." The researchers compiled a list of 175 introduced species which had been introduced by people since the year AD 1500, after which time human global travel increased exponentially. They then created a subset list of 140 native species to be compared with. Altogether, the places the species occurred prior to 1500 represented every continent besides Antarctica and "most of the major climatic types and biogeographic realms of the world."

The list of species in their native ranges was compared to the list of species in their present ranges for "compositional dissimilarity," or the varietybetween species of different regions.The researchersfound that when looking at their native ranges, the gastropods could be grouped according to more specific geographic regions, as shown here, with more similar species living closer together. Indeed, "none of the represented species are shared [between locations] beyond ~11,000 km." This chart shows the regions examined listed along the side and again along the bottom. The lower triangle shows the relative proportion of native species shared between each place, with blue indicating a low proportion and red a high proportion. The upper triangle shows the absolute number of native species shared,with green indicating a low number and red a high number. The diagonal shows the totalnumber of native species found in the region, with black indicating a high number and light grey a low number. Notice the prevalence of blue and green, showing higher rates of species dissimilarity between geographic regions.

*In contrast, this map shows the present distribution of terrestrial gastropod species. Unlike the first map, where we could see similar species living closer together in the same region, here we see the

species composition determined primarily by climate, with temperate regions around the world having more species in common and tropical or subtropical regions around the world likewise having more species in common. * This chart for present species distribution shows the same regions as the first chart, but notice that the lower triangle is now much less blue and the upper triangle is mostly yellow rather than green, meaning that different regions now have more species in common.

*These charts offer a side-by-side comparison between native and present distributions, showing the changed relation of compositional dissimilarity with distance. The vertical axes indicate dissimilarity, which increases downward, while the horizontal axes indicate distance, which increases to the right. On the left we see the native distribution, with a clear correlation curve showing that the composition dissimilarity between regions increases with their geographic distance from each other. On the right is the present distribution, where that correlation has essentially vanished.

*The study, however, did not stop there. They also looked more specifically for any correlation between international trade and species distribution patterns.Altho some gastropods have been introduced deliberately, most have been spread unintentionally on trade commodities such as plant products. This chart takes the dissimilarity between regions and shows what percentage of it is explained by what predictive factors.The left column shows the explanatory factors for dissimilarities between the native ranges of species while the middle and right columns show the explanatory factors for dissimilarities between present species distributions. Light grey shows the deviance explainedby climate alone, mid-grey by distance alone, dark grey bygeographical distance and shares of total trade, black bygeographical distance and shares of selected commodities,and white by both climate and the other factor in the same column. “Percentages of total deviance in compositional dissimilarity explained by the full model [used to calculate these] are shown above each bar.”As the researchers said, “Our results also suggest that homogenization will be greater among regions that have intense trade relations and that are closely located.”

Paper 2

*The second paper is titled “Tsunami-driven rafting: Transoceanic species dispersal and implications for marine biogeography.” After the 2011 Japanese tsunamis, amassive amount of debris was suddenly washed into the ocean, causing a trans-oceanic voyage to Hawaii and the North American west coast of mostly synthetic objects unprecedented in its transport ofa biological community as diverse as it wasthat far a distance. Landings of objects concentrated along the Washington and Oregon coasts, as seen on the map.

*Japanese tsunami marine debris, or JTMD for short, began landing in 2012 and continued to land while this study was being made 5 years later, altho landings of some kinds of objects had begun to decline, including large objects that carried over 20 species each. This chart shows the cumulative species-richness of certain categories of debris over the five years since arrivals began. Note that species accumulations often increase during spring-times. These “were most pronounced in the Pacific Northwest and were associated with springtime southwesterly or downwelling-favorable winds.”Live specimens of new species were still being found in 2017, “4 or more years longer than previous

documentedinstances of the survival of coastal species rafting in the ocean." Some species even showed signs of having reproduced during their transit.

*Some of those objects, as wellas their passengers, are seen here, ranging in size up to things as large as boats and docks. The researchers studied 634 pieces of JTMD, finding "a minimum of 289 living invertebrate and fish species arriving from Japan,none of which were previously reported to have rafted transoceanically between continents."*However, 35% of the JTMD species found "were previously known to occur on the Pacific coast of North America, largely due to presumed natural amphi-Pacific ranges." Seven JTMD species had previously been introduced to the American coast.The chart on the left shows different types of JTMD and the species richness of each. Blue here indicates species unique to that JTMD type. The chart on the right shows different animal taxa represented on JTMD. Blue here indicates species, native or previously introduced, already present on the North American coast. Note that mollusks formed the most abundant group found, which shouldn't be surprising given that they glue themselves in colonies to docks and vessels. Other groups found include algae, marine worms, sponges, cnidarians, crustaceans, fish, and other coastal, marine species. Altho some trees had been found drifting from the tsunamis, no terrestrial species were found living.

* These charts show data on average species richness per object for "a subset of 110 JTMD objects that were most thoroughly sampled for macrobiota" (species large enough to be seen unaided). The left chart shows species richness per year, the middle chart shows it for JTMD type, and the chart on the right shows it for both when (days after the first interception) and where (Hawaii or continental North America) these JTMD objects were found.

* The facts that many of the JTMD species already have established populations on the eastern Pacific coast; that JTMD species showed a robustness in surviving and even thriving the voyage across the ocean; and that debris landings often occur in spring when temperatures will be more conducive for life, all indicate the strong likelihood that species rafted from Japan can establish invasive populations on the North American coast.

* Rafting by synthetic material is a relatively new method of possible species dispersal, and will likely only grow in its future impact. As a vector for the geographic expansion of species, it is unique in many ways that will potentially make it the means for a great many more introductions. For example, synthetic material usually not being biodegradable allows for more stable transit of species across long distances, and staying on a different shore instead of turning and sailing away like a ship gives species more time to adapt. Earthquakes and tsunamis of comparable magnitude occurred in Japan in 1896 and 1933, before the invention and use of many synthetic materials, and were not followed by a mass transportation of Japanese species to the American Pacific coast. Especially as coastal urbanization increases, rafting will likely become a more important factor in changing biogeography.