BIOGEOGRAPHY

Tsunami-driven rafting: Transoceanic species dispersal and implications for marine biogeography

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The 2011 East Japan earthquake generated a massive tsunami that launched an extraordinary transoceanic biological rafting event with no known historical precedent. We document 289 living Japanese coastal marine species from 16 phyla transported over 6 years on objects that traveled thousands of kilometers across the Pacific Ocean to the shores of North America and Hawai'i. Most of this dispersal occurred on nonbiodegradable objects, resulting in the longest documented transoceanic survival and dispersal of coastal species by rafting. Expanding shoreline infrastructure has increased global sources of plastic materials available for biotic colonization and also interacts with climate change–induced storms of increasing severity to eject debris into the oceans. In turn, increased ocean rafting may intensify species invasions.

Transoceanic rafting is a fundamental feature of marine evolutionary biogeography and ecology, often invoked to explain the origins of global patterns of species distributions (*1*, *2*). Until now, however, there have been no direct observations of rafting episodes transporting diverse living communities of coastal marine organisms long distances from one continental margin to another. On 11 March 2011, an undersea megathrust earthquake measuring 9.0 moment magnitude struck Japan. The earthquake created a tsunami reaching 38.38 m in height on the Tōhoku coast of Honshu (*3*). In the ensuing coastal devastation, millions of objects ranging in size from small plastic fragments to fishing vessels and large docks were carried into the Pacific Ocean. These items (Fig. 1) already supported diverse communities of marine life or were colonized by marine organisms after entering the ocean and were then transported by ocean currents from the Western Pacific to the Central and Eastern Pacific Ocean (fig. S1). Hence, this event provided the opportunity to track and evaluate the fate (destination and species composition) of the biologically rich debris field over multiple years from a single known time and place of origin.

Since 2012, debris with living species originating in Japan has landed on coastlines from Midway Atoll to Hawai'i Island and from south central Alaska to central California. Debris landing in the contiguous United States traveled at least 7000 km from Japan. We assessed the diversity of animal communities on 634 Japanese tsunami marine debris (JTMD) objects (table S1), consisting of vessels, docks, buoys, totes (crates), wood, and many other objects, identified as JTMD by multiple criteria (*4*). Object landings continued across the entire 5-year study period (fig. S1), showing no asymptote, although arrivals of several individual object types have slowed or declined (fig. S3 and fig. S4A).

We documented a minimum of 289 living invertebrate and fish species arriving from Japan (table S2A), none of which were previously reported to have rafted transoceanically between continents (*4*). This biota included macroinvertebrates (235 taxa), fish (2 taxa), microinvertebrates (33 taxa), and protists (19 taxa). Additional species continued to arrive through February 2017, increasing total species richness detected over time (Fig. 2). Microinvertebrates and protists could not be sufficiently preserved and thus were not adequately assessed on most JTMD objects, compared with macrobiota (*4*). For macrobiota, 59.6% of all taxa were detected on vessels, and 24.5% were found only on vessels (Fig. 3A). Moreover, mean species richness was greater on large-sized objects (5 to 12 m in length, including vessels and docks) than small objects (<1 m in length) ($P < 0.01$) (figs. S5 and S6).

Five invertebrate groups (mollusks, annelids, cnidarians, bryozoans, and crustaceans) composed 85% of the species diversity of macrobiota (Fig. 3B) (*5*). Recorded JTMD landings and macrobiotic richness exhibited strong geographical and temporal variation. Landings and richness were concentrated in the Pacific Northwest (Oregon and Washington) between North latitudes 42°03.27' and 47°54.19', a pattern consistent across all object types (figs. S7 and S8). We documented peak richness in 2012 to 2014 for each object type and region (fig. S7 and fig. S4), 2 to 3 years after debris entry into the Western Pacific Ocean. Strong spring pulses were evident for both landings and species accumulation for each year between 2012 and 2016 (Fig. 2 and fig. S2). These pulses were most pronounced in the Pacific Northwest (*5*) and were associated with springtime southwesterly or downwelling-favorable winds.

Temporal analyses of a subset of 110 JTMD objects that were most thoroughly sampled for macrobiota [higher-resolution objects (JTMD-HR) (*4*)] show that mean per capita richness/object did not decline across years (Fig. 4A and fig. S4C). This is best illustrated for vessels, which exhibited relatively high per capita richness (Fig. 4B and fig. S4B) and no significant temporal decline in per capita richness for arrivals to either North America or Hawai'i (Fig. 4C). However, the detection rate of landings has declined since 2015 (figs. S2 and S3A), causing total richness per year for JTMD-HR to also decline from 2012–2014 peaks (fig. S3C).

It is noteworthy that the frequency of high-richness arrivals (>20 species per object) declined from 2012 to 2016 (Fig. 4A). A large dock (Fig. 1A) arriving in June 2012 with ~80 macroinvertebrate species was followed by another dock (fig. S1) and vessels between late 2012 and spring 2015 with between 20 and 50 species; only one object has arrived since the summer of 2015 with >20 species. This decline in high-richness arrivals may result from the oceanic environment through which JTMD has passed for 6 years, a habitat generally viewed as inhospitable [due to lower trophic resources, increased ultraviolet B exposure, and other stressors (*6*)] for shallow-water coastal species.

Our analyses provide minimum estimates of the biodiversity and landings from the massive debris field launched in 2011. For macrobiota alone, rarefaction curves are far from saturation (figs. S9 and S10), indicating that many more taxa arrived than were detected. This interpretation is supported by the low frequency of species occurrences (fig. S11), where (i) more than 50% of all taxa were detected only once over the 5-year study period and (ii) new species, as noted above, were still being detected on landings in 2017 (Fig. 2 and fig. S4C). Chao richness estimates indicates that total macrobiota taxa approach 357 ± 41 species for all JTMD-HR object types, or an average increase of 63% from observed taxa ($n = 226$) (table S4). Although we surmise that sufficient biofouled debris existed to approach this asymptote, several phenomena prevented sampling the debris field comprehensively (*4*). Although we detected more than 50 microinvertebrate and protist taxa, these are undoubtedly major underestimates of the species pool. Furthermore, most of these measures do not yet evaluate cryptic taxa, symbionts, parasites, and genetic variants.

It is surprising that living species from Japan continue to arrive after nearly 6 years at sea, 4 or more years longer than previous documented

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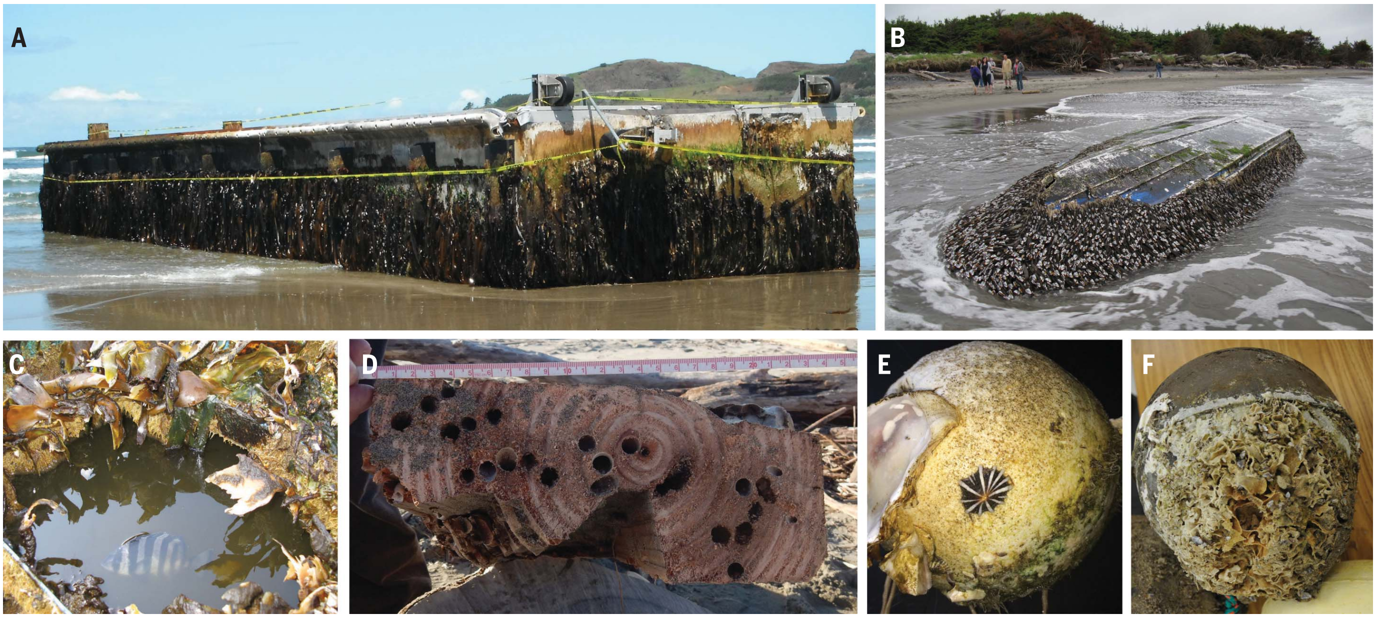

Fig. 1. Japanese tsunami marine debris rafts and associated biota. (**A**) Fisheries dock (JTMD-BF-1) (*4*) from the Port of Misawa, Aomori Prefecture, washed ashore 5 June 2012 on Agate Beach, near Newport, Lincoln County, Oregon (photograph by J. W. Chapman). (**B**) A fishing vessel (JTMD-BF-2), washed ashore at Ilwaco, Pacific County, Washington, 15 June 2012, heavily covered with the pelagic gooseneck barnacle *Lepas*; living Japanese fauna included barnacles, isopods, amphipods, and mussels (photograph by A. Pleus). (**C**) Japanese barred knifejaw fish *Oplegnathus fasciatus* in the stern well of the fishing vessel 斎勝丸 (*Sai-shō-Maru*) (JTMD-BF-40) from Rikuzen-takata, Iwate Prefecture, washed ashore 22 March 2013, on Long Beach Peninsula, Pacific County, Washington (photograph by A. Pleus). (**D**) Post-and-beam wood (JTMD-BF-297) from Tōhoku coast, Honshu, washed ashore 1 April 2013, at Bandon, Oregon, and heavily bored by the Japanese shipworm *Psiloteredo* sp. (photograph by N. C. Treneman). (**E**) Buoy (JTMD-BF-207), found floating inside the Charleston Boat Basin in Coos Bay, Coos County, Oregon, on 17 May 2014; living Japanese limpet *Siphonaria sirius* in center, next to dead Japanese oyster *Crassostrea gigas* (photograph by L. K. Rasmuson). (**F**) Buoy (JTMD-BF-216), washed ashore at Dunes City, Lane County, Oregon, with large foliaceous living colonies of the Japanese bryozoan *Biflustra grandicella* (photograph by A. Marohl).

instances of the survival of coastal species rafting in the ocean (*7*). Long-term surviving species included the mussel *Mytilus galloprovincialis*, the barnacle *Megabalanus rosa*, limpets, bryozoans, sea anemones, amphipods, isopods, additional bivalves, and other taxa. This at-sea long-term longevity is due in part to (i) the multiyear growth, aging, and unexpectedly long survival of some original individuals departing Japan in 2011 and (ii) self-recruitment by other species via reproductive strategies that produce and maintain multiple generations on these floating islands. Diverse taxa across at least 13 phyla and orders arrived in reproductive condition (table S2A), and population size structure revealed that multiple cohorts were common, indicating that reproduction had occurred during ocean transit. Marine species across many phyla having nonplanktonic propagules or extremely short-term dispersal capacity may thus have been strongly favored (*6*). Plastic debris can persist in the oceans for decades [(*8*) and below], and yet our knowledge of associated biota is strikingly limited, especially relative to the physiological processes involved in the long-term survival of coastal species in an environment (*6*) in which they did not evolve.

Upon arrival on new shores, the establishment of rafting species will depend on the number and frequency of delivery of reproductively viable individuals (*9*, *10*) and the presence of a suitable

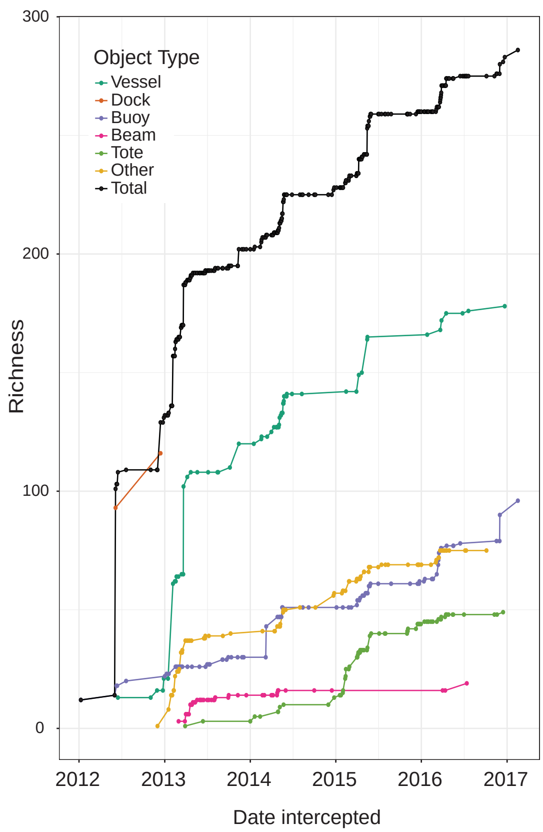

Fig. 2. Cumulative Japanese living protist, invertebrate, and fish species richness by date and object type. Species accumulation for 289 taxa detected from Alaska to California and Hawai'i from June 2012 to February 2017 by object type (table S1 and fig. S2): Vessels are primarily skiffs ranging from 4 to 11.5 m in length; docks are JTMD-BF-1 and JTMD-BF-8, landing in central Oregon (June 2012) and northern Washington (December 2012), respectively (fig. S1); buoys are anchored or attached floats used in aquaculture, small harbors, and navigation; beams are post-and-beam timber (mortise-and-tenon construction) of standard Japanese dimensions; totes include crates, boxes, and cases used in fisheries and for domestic purposes; "other" includes pallets, pontoon sections, ropes, trays, propane tanks, carboys, items associated with the aquaculture and fisheries industries, and many other objects. Post-and-beam pieces detected in 2016 may represent redrift (washed back out to sea after earlier landings), rather than being at sea since 2011. JTMD spring landing concentrations are evident in all years.

environment, among other factors. At least 35% of JTMD species were previously known to occur on the Pacific coast of North America (Fig. 3B), largely due to presumed natural amphi-Pacific ranges. These preoccurring species indicate a climatic match as well as a broad range of matching habitats. In addition, 82 invertebrate species from Japan have previously become established on the Pacific coast in historical time (before the JTMD phenomenon), introduced by multiple vectors (*11*, *12*). Of these, only seven species were represented in the JTMD fauna (*5*). The robustness of a wide phyletic range of species in this rafted fleet, as manifested in their multiyear at-sea longevity and production of multiple generations, also underscores a physiological and reproductive plasticity often linked to invasion success (*13*). Further, arrival in the northeast Pacific during spring (above) provides potentially highly conducive environmental conditions, including increased productivity and warming waters, for reproduction and possible recruitment of rafted species. Introductions related to JTMD arrival have not yet been detected. However, lag times

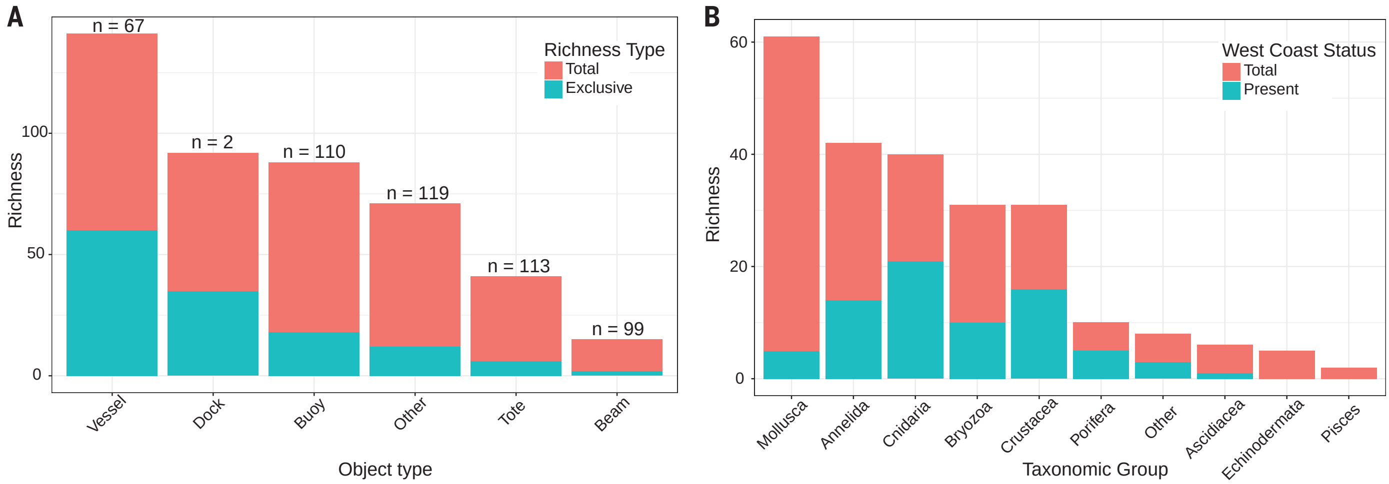

Fig. 3. Living Japanese macroinvertebrate and fish species richness by object type and taxonomic group. (**A**) Total richness by object type landing from Alaska to California and Hawai'i, as described in Fig. 2; number of species exclusive (unique) to a given object type are in blue; "n" is the number of objects in each category of the total 510 items (excluding 124 items on which only dead individuals or algae were documented). (**B**) Species diversity by taxonomic group. Number of species already present (due to natural distribution or previous introductions) on the west (Pacific) coast of North America is in blue. "Other" taxa are Nemertea, Sipuncula, Insecta (Diptera), Pycnogonida, Acarina, and Kamptozoa.

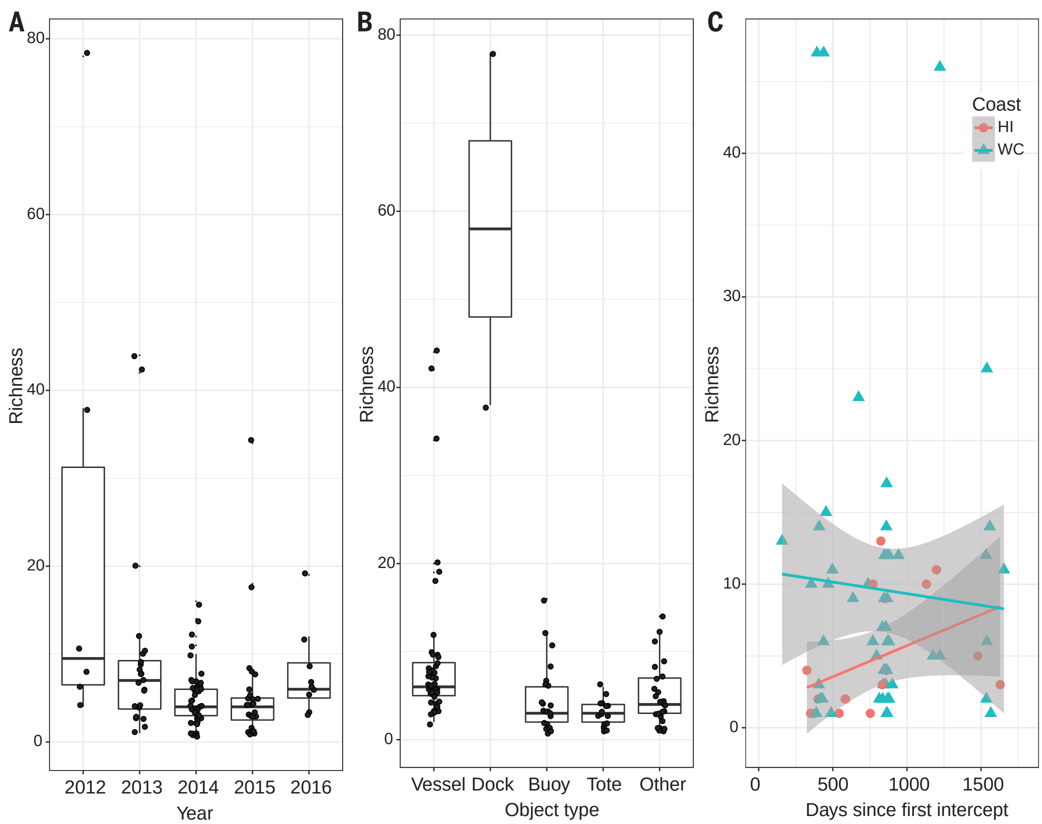

Fig. 4. JTMD richness per object and time. (**A**) Quartile plot of richness by year, based on 110 JTMD-HR (higher-resolution) objects (see text and supplementary materials). Peak per capita richness occurred in 2012 to 2013, with richness falling below 20 species per object since 2015. There was a significant decline in high-richness objects over time (r^2 = 0.2357; $P < 0.05$), based on the upper quartile of each year. (**B**) Quartile plot of richness by object type, based on 110 JTMD-HR objects; two docks in 2012 and vessels (regardless of year) account for all high (>20 species) richness items (Fig. 3A and fig. S4B). (**C**) Linear regression of per capita JTMD richness (as days since first interception) for HR vessels alone; shaded areas are the 95% confidence intervals around the linear model (slope and *y* intercept) parameters. Although outlier high-richness events decline (A) there is no significant decline (C) in per capita richness over time for the west coast of North America (WC) (r^2 = 0.0039; P = 0.6537) or Hawai'i (HI) (r^2 = 0.1518; P = 0.1221).

in the growth of non-native species populations are widely recognized (*14*), such that detection of new invasions may not occur for years or decades.

Marine debris as effective long-distance oceanic rafts for the transport of coastal species is distinct mechanistically, temporally, and spatially from other, better-known anthropogenic vectors of non-native species. Rafts are slow-moving (1 to 2 knots) compared with commercial vessels (20 to 25 or more knots) (*15*), speeds that influence the development, adhesion, retention, and self-recruitment of sessile fouling species (*16*). Further, rafts provide potential acclimatization time for attached biota to adjust to changing environmental conditions during long transits. Megarafts of marine debris deliver substantial communities of adult organisms capable of reproduction [as compared with planktonic stages of benthic species arriving in ballast water (*17*)]. Rafts are one-way arrival and deposition events (as opposed to transient biofouled vessels entering and then departing ports and harbors in hours or days), such that adult rafted communities, drifting in coastal waters or after landing, may benefit from extended periods of residence time permitting species' reproduction. Notably, marine debris landings may also expose a vastly greater diversity of coastal habitats, and thus communities, to novel biotas, beyond the harbors and ports receiving international vessel traffic.

Rafted anthropogenic debris also differs strikingly from natural rafts. Natural long-distance ocean rafting consists of largely ephemeral, dissolvable, or decomposable materials, including biodegradable terrestrial vegetation (trees, root masses, and seeds) (*7*, *18*) and pumice (*5*, *19*), all with far shorter at-sea half-lives than fiberglass, polystyrene, and polyvinyl chloride–based objects (*8*). Despite the tsunami-induced loss of large expanses of forests on the northeast Honshu coast (*3*), few stranded Japanese trees, typically with few attached species, were observed in North America or Hawai'i (*5*). Most trees may have stayed on land or washed ashore in Japan, or may have sunk before undergoing or completing ocean transit. Further, building wood, which had commenced arrival in large quantities in 2013 (also with relatively few species) (Fig. 3A), largely tapered off by 2014 (Fig. 2 and fig. S2). This highly constrained, largely 2- to 3-year (2011 to 2014) at-sea existence of wooden JTMD is due in large part to destruction by wood-destroying teredinid mollusks (shipworms) [(*5*) and Fig. 1D]. Perhaps not surprisingly, then, before 2012 there are no reports of Western Pacific vegetation or wood arriving with communities of living Japanese species in either the Hawaiian Islands or North America, despite >150 years of shore observations by scientists, suggesting that such events are rare.

The recent and increasing availability and use of plastic materials in the latter half of the 20th century (*20*), and their ability to sustain rafting integrity for the lengths of time required for frequent transoceanic dispersal, may thus explain the apparent failure of debris from previous tsunamis to be detected in the North Pacific Ocean. Earthquakes and their resulting tsunamis in the Tōhoku region of northeast Honshu have been recorded for more than 1000 years (*21*). The two most recent events before 2011 of comparable magnitude and wave height occurred in 1896 (the Meiji-Sanriku earthquake) and 1933 (the Sanriku earthquake) (*21*). Before the 1930s to 1940s, these coastal plains of Tōhoku were more rural than urban (*22*), and appreciable amounts of plastic-based material were not present. Fiberglass (of which much of the present debris is composed, especially the many vessels) was not available until 1936 (*23*), and extruded polystyrene foam (a critical component of the Misawa docks, and present in much other debris) was not marketed until the 1940s (*24*), with neither widely used until after the 1950s. Despite the growing cities and expanding coastal populations and fishing communities of the Pacific Northwest of the late 19th and early 20th centuries, we have found no reports of Japanese debris arriving in North America after the 1896 and 1933 tsunamis (*4*). In contrast, long-lasting, nonbiodegradable debris has been added in the late 20th century to the world's oceans. That Western Pacific coastal species survived for, to date, nearly 6 years drifting to the Central and Eastern Pacific indicates that shallow-water species can undergo long-term transoceanic dispersal events if provided permanent rafts.

Most of the world's megacities are in the coastal zone and will continue to be so (*25*), greatly increasing the quantity of nonbiodegradable material available to be swept from watersheds and off of coasts. Large storms also inject debris fields into the ocean (*26*, *27*); in turn, cyclones (hurricanes and typhoons) and other storm activities are increasing due to global climate change (*28*, *29*). Human-mediated amplification of marine debris provides new opportunities for species to surmount historic ocean barriers (*30*–*33*).

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SUPPLEMENTARY MATERIALS

www.sciencemag.org/content/357/6358/1402/suppl/DC1
Materials and Methods
Supplementary Text
Figs. S1 to S11
Tables S1 to S6
References (*34*–*55*)

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Science

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Long-distance life rafting

When coastal ecosystems are affected by storms or tsunamis, organisms can be rafted across oceans on floating debris. However, such events are rarely observed, still less quantified. Carlton *et al.* chart the rafting journeys of coastal marine organisms across the Pacific Ocean after the 2011 East Japan earthquake and tsunami (see the Perspective by Chown). Of the nearly 300 mainly invertebrate species that reached the shores of the U.S. Pacific Northwest, most arrived attached to the remains of manmade structures.

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Supplementary Materials for

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This PDF file includes:

Materials and Methods
Supplementary Text
Figs. S1 to S11
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Materials and Methods

Sample Acquisition and Processing

Following the arrival in June 2012 of a large fisheries dock (Fig. S1) from Misawa and of several Japanese vessels and buoys along the Oregon and Washington coasts (table S1), we established contact with local, state, provincial, and federal officials, private citizens, and environmental (particularly "coastal cleanup") groups, in Alaska, British Columbia, Washington, Oregon, California, and Hawaiʻi. Between 2012 and 2017 this group grew to hundreds of individuals. We advised our contacts that we sought to acquire either samples of organisms (alive or dead) attached to suspected Japanese Tsunami Marine Debris (JTMD) or the objects themselves (numerous samples and some objects were received that were North American in origin, or that we interpreted as likely discards from ships-at-sea). We provided written or verbal directions to searchers and collectors relative to sample photography, collection, labeling, preservation, and shipping. Some of us (especially JWC and JAM) responded to reports of objects freshly washed ashore on the Oregon and Washington coasts. Marine biologist colleagues in AK, BC, WA, OR, CA, and HI further responded to our requests to seek out and examine objects to which we had been alerted as newly washed ashore, and to then acquire samples if practical.

Samples from WA and OR were largely assembled at the Miller Laboratory and Chapman Laboratory at Hatfield Marine Sciences Center of Oregon State University and then sent to the Carlton Laboratory at the Williams College-Mystic Seaport Maritime Studies Program in Mystic, Connecticut. Samples from AK, BC, CA, and HI were primarily sent directly to the Carlton Laboratory. Samples initially identified as JTMD were assigned unique numbers (JTMD-Biofouling (BF)-) based on order of receipt or of information received and thus are not necessarily in chronological order (Table S1). Items with Japanese species were confirmed as JTMD per the criteria detailed below.

Selected samples for demography, growth studies, reproductive analysis, shell chemical composition, and other analyses were retained in Newport. Samples for genetic analyses (barcoding and metagenomics) were sent to the Geller Laboratory at Moss Landing Marine Laboratories, Moss Landing, California. Mussel and other bivalve samples for parasite analysis were sent to the Ruiz Laboratory at the Smithsonian Environmental Research Center in Edgewater, Maryland USA. Initial preservation methods included freezing or preservation in ethyl alcohol or in buffered formaldehyde.

Once samples arrived in the Carlton Laboratory, they were sorted for any invertebrates larger than 1.0 mm in body length, although smaller protists and microinvertebrates, when encountered, were noted and at times archived as practicable. Eighty taxonomists in 13 countries (table S5) were sent specimens for identification or were consulted for their expert advice.

Wood from Japanese trees, milled logs, and other items was presented to the Department of Wood Science and Engineering, College of Forestry, Oregon State University, for thin sectioning and identification to the lowest taxonomic level (family, genus, or species) possible.

JTMD Size Categories

We assigned all objects to one of four size categories: "small" (< 1 m in length); "medium" (1 to 5 m); "large" (5 to 12 m), and "extra large" (13+ m). Size was determined through direct measurements of each object or by estimates based upon photographs.

Small items included buoys, bottles, styrofoam fragments, and tires; medium items included buoys, pallets, cylinders, post-and-beam wood, vessel fragments, and more; large items included trees, vessels, larger post-and-beams; extra-large items were two docks from the Port of Misawa and one tree. Two of the three extra-large items did not exceed medium or large items in richness; thus pairwise richness comparisons were made (figs. S5 and S6) only between small, medium, and large objects.

Debris Field Sampling

We collected or received only a fraction of the total JTMD field. From discussions with local officials, including county, state, and federal beach authorities and with members of the public and conservation groups, it is clear that a large number of objects discovered by the public and recognized as probable tsunami-related were not formally reported (including being removed by the public for private acquisition); in turn, many items that were also tsunami-related were not recognized as such. Large sections of the North American and Hawaiian Island coasts are relatively inaccessible, and thus not amenable for searching. Rocky shores, in particular, are visited by the public far less than sandy beaches, and a large fraction of JTMD reaching these shores may be destroyed on impact. Finally, beach debris clean-up campaigns removed and destroyed large amounts of material before scientific examination was possible.

Identification as Japanese Tsunami Marine Debris

We used a broad suite of criteria to determine if an item was directly linked to loss due to the tsunami on March 11, 2011 from the Japanese coast. To date, all items which could be linked to a specific location in Japan have come solely from the four prefectures (Aomori, Iwate, Miyagi, and Fukushima) impacted most by the tsunami (*3*).

Formal identification

Many vessels, buoys, and additional items had registration or other identification numbers, or specific place (including owner) names that could be traced to loss on March 11, 2011, by the Consulate of Japan or through direct communication with owners. Vessels with registration information were accompanied by prefecture codes, as follows: IT, Iwate; AM, Aomori; MG, Miyagi, and FS, Fukushima.

Known Japanese manufactory

Based upon initial research by S. Holland, District of Ucluelet, British Columbia, post-and-beam (mortise-and-tenon construction) manufactured lumber was identified by means of standard Japanese dimensions (*34*). This building construction wood appeared suddenly in 2013 on beaches in North America and the Hawaiian Islands where no such wood had been observed for decades by experienced beachcombers and beach-walkers.

Bioforensics: source region biological fingerprint

JTMD-identified items generally supported marine life typical of the colder waters of Japan's Tōhoku coast, that is, the northeast coast of Honshu north of the Boso Peninsula. This region supports a biogeographically discrete fauna (*35*). Thus, arriving biota represented a largely non-random "fingerprint" of the portion of the Japanese coast hit hardest by the Great East Japan Earthquake and Tsunami. For example, characteristic biota of the Tōhoku coast present on JTMD were the mussel *Mytilus galloprovincialis*, the clam *Hiatella orientalis*, the barnacle *Semibalanus cariosus*, the amphipod *Jassa marmorata*, and the sea anemone *Metridium dianthus*, whose identifications were supported by genetic analysis. Some objects from the Tōhoku coast arrived in North America and in the Hawaiian Islands with additional species from south of the Boso Peninsula, indicating that these items either drifted south to acquire warmer-water elements, or that southern larvae are entrained in the ocean currents moving north, or both. Non-JTMD objects with living taxa would be recognized biologically by having species communities characteristic of other biogeographic regions of the Western Pacific Ocean (such as Russian waters to the north of Japan, or Chinese, Korean, or southeast Asian waters to the west or south of Japan) (*35-38*), but no such animal communities were found on the rafted objects studied by us from Alaska to California and the Hawaiian Islands between 2012 and 2017.

Pulse event window commencing in 2012

No large, steady stream of marine debris from the Tōhoku coast has been previously recorded as arriving in North America or in the Hawaiian Archipelago. In contrast, commencing in the spring and summer of 2012, a novel pulse of a wide range of debris items (table S1) began washing ashore from the tsunami source region. As expected from a unique pulse event, this debris field has been diminishing (fig. S2), a phenomenon that would not be expected if debris was arriving in quantity from the Western Pacific (and specifically from Japan) on a continual basis. The decline in the number of items reported per year is not due to decreased search effort over time: several of our debris acquisition regions have been under the same level of steady and intensive monitoring continuously since 2012 (for example, the 45.06 km beach of the Long Beach Peninsula (Pacific County), Washington (Table S1), surveyed by vehicle by R. Lewis (Ocean Park WA) on a largely daily basis, and the beaches from Gold Beach (Curry County) to Brookings (Coos County), in southern Oregon, a distance of 45.06 km, surveyed on a weekly or monthly basis). Further, items arrived in a non-random fashion by windage characteristics: items with very high windage (buoys, pallets, some vessels (skiffs), the ship *Ryou-un-Maru*, and the first Misawa dock) arrived in the spring and summer of 2012; many additional small vessels, with lower windage, began to arrive in November 2012, and items driven largely by ocean currents (as opposed to surface winds) then commenced arrival in the winter-spring of 2013, such as post-and-beam building wood, and, shortly thereafter, trees, pilings, and heavier wood beams. Objects in all windage categories, including styrofoam buoys, continue to arrive, as debris is caught up for years in ocean gyres.

Novel debris pulse arriving with communities of living Japanese species

We have found no published records of any objects landing in North America or Hawaiʻi prior to 2012 with diverse communities of living species from Japan. Observations of marine life in both regions commenced on a regular basis in the 1850s-1860s (*39-40*). No JTMD species has been reported in previous scientific, historical, or policy literature as rafted transoceanically from one continental margin and landing on another continental margin. "Japanese glass fishing floats" found washed ashore in Alaska and the Pacific Northwest typically support native oceanic barnacles (*Lepas* spp.) reflective of their loss on the high seas, versus having originated from coastal or port environments. Our extensive searching of beachcomber websites, as well as inquiry among veteran beachcombers on the North American Pacific Coast, yielded one buoy collected in 2004 in Washington with three living species (the barnacle *Megabalanus rosa*, the clam *Hiatella orientalis,* and sponge *Halichondria* sp.). This buoy was an object judged to be sufficiently rare that it was retained as unique by a searcher with more than two decades of beachcombing experience in the Pacific Northwest. We also searched beachcomber websites and popular books (*41-44*). In contrast, a *sui generis* field of debris, identified to a source area, began to land in North America and Hawai'i in 2012 and 2013, with communities of living Japanese species.

<u>JTMD objects with a more thorough sampling history</u>

Based upon our knowledge of the specific circumstances associated with each JTMD-BF object, we focused some of our analyses (below) on those items that received more thorough sampling of the sessile and mobile species of macroinvertebrates in object biofouling communities. For example, we were able to determine for many objects the relative length of time a given item was ashore before being found and sampled; we knew the level of expertise of many collectors relative to the probability that they recognized and sampled smaller-bodied taxa; we were able to establish for many items the amount of time that an object had been available for, and subjected to, sampling, as well as knowing how samples were subsequently handled, transported, and preserved. Based upon these assessments, we identified a subset of 110 objects (asterisked in Table S1) that were identified as having higher resolution assessment for the diversity of macroinvertebrates and fish (macrobiota) aboard. These are referenced in this study as Japanese Tsunami Marine Debris - Higher Resolution (JTMD-HR) items.

<u>Biodiversity assessments, biogeographic affiliations, and prior oceanic dispersal history</u>

We documented as well the native obligate rafters (*6*) present on JTMD, but none of these species were included in our calculations. These neustonic species, found naturally on the high seas, included hydroids, polychaetes, caprellid amphipods (*45*), crabs, *Lepas* gooseneck barnacles (Fig. 1B; *46*), nudibranchs (*47*) and bryozoans, as well as two species of teredinid bivalves (shipworms) found primarily in oceanic wood (Table S2B). We also documented North East Pacific invertebrates (Table S2C) that settled as larvae (and appeared as nepionic recruits typically 1-2 mm in size) or swam onto JTMD as items floated in nearshore waters prior to landing. Additional native Pacific coast and Hawaiian littoral species occasionally moved onto landed debris. These coastal and shore acquisitions were also excluded from our analyses. To determine which if any taxa had been previously documented as having been transported on rafted materials (natural or anthropogenic) from one continental margin to another, we compared JTMD species lists to the rafting biota summarized or documented in *6-7, 18-19, 30-31,33, 48*.

<u>Temporal and spatial calculations of JTMD biodiversity patterns</u>

Cumulative species richness patterns are based on 289 species of macroinvertebrates, microinvertebrates, protists, and 2 fish species. Finer-grained spatial and temporal diversity patterns are based on 237 living taxa (289 species less 33 microinvertebrates (nematodes, flatworms, copepods, ostracods, mites) and less 19 protists, whose diversity over space and time could not be fully assessed throughout the study period). Certain diversity calculations, as noted in the text and figure captions, are further based on the subset of 110 objects (including 43 vessels) defined as JTMD-HR above. We excluded 38 species (primarily bivalve mollusks and bryozoans) from all analyses that we judged conservatively to be dead upon arrival, although some of these may have died only after shore landing, or may have arrived alive on other undocumented debris. For species occurrences per object, see database in dryad depository provided in Acknowledgments.

Search for evidence of North American Japanese object landings after the 1896 and 1933 Japanese tsunamis

Databases of historical newspapers of Washington and Oregon, and other historical digital archives, were searched for the years 1897 and later (following the June 1896 Meiji-Sanriku Earthquake and Tsunami) and 1934 and later (following the March 1933 Sanriku Earthquake and Tsunami) (*49-51*). Search terms included tsunami, beach wreckage, beachcomb-, beach drift, Japan-, in various combinations. To date, we have found no records of objects lost from the Tōhoku coast in 1896 and 1933 being washed ashore in North America or Hawaiʻi. Beachcombing in the Pacific Northwest was common by the 1870s and 1880s, if not earlier (*52*), and searching for Japanese glass floats became a common avocation by the 1920s-1930s (*45*). There were fewer scientists and lower populations in the Pacific Northwest in the 1890s and 1930s than now, and thus while it would not be surprising if limited records of the landfall of objects from these earlier events were to be discovered, it appears unlikely that a large debris field equivalent to that generated by the 2011 Great East Japan Earthquake and Tsunami came ashore in North America or the Hawaiian Islands and went unrecorded.

Statistical Analyses

Species accumulation (rarefaction) analyses were made with the specaccum function of the R package "Vegan" version 2.4-3 (*53*). Linear regression was done in R as well. The Tukey Honest Significant Differences (HSD) analysis was done with the TukeyHSD function in R Stats package version 3.4.0.

Supplementary Text

Most frequent Japanese taxa on tsunami debris

The most frequently occurring Japanese taxa included the Mediterranean mussel *Mytilus galloprovincialis* (on 51.1% of all objects, and itself a 20th century invasion of Japan), the bryozoan *Scruparia ambigua* (on 39.7% of objects), aeteid bryozoans (13.5%), the barnacle *Megabalanus rosa,* the amphipod *Jassa marmorata* (also not native to Japan), the isopod *Ianiropsis serricaudis,* and the bryozoan *Bugula* sp., with all the latter occurring on between 6.8% and 8.8% of objects) (Table S3).

Spring and winter debris landings

Landings were unevenly distributed among seasons. Spring JTMD landings across all years on the Pacific coast comprised 62% of total landings across all seasons for vessels, and 42% for all objects. For the first 6 months of all years, the combined winter and spring landings account for 90% of vessel landings and 77% of total object landings, respectively.

Previously introduced JTMD Japanese species on the Pacific Coast of North America

Species introduced from Japan by other vectors and also found on JTMD are *Diadumene lineata* (Anthozoa), *Crassostrea gigas* (Bivalvia: Ostreidae), *Caprella mutica and Caprella drepanochir* (Amphipoda), *Ianiropsis serricaudis* (Isopoda), *Schizoporella japonica* (Bryozoa), and *Didemnum vexillum* (Ascidiacea) (*11*).

Pumice rafting

Pumice is capable of rafting potentially long-distances, but individual clasts generally support few epilithic species, and pumice may sink under the weight of epibiota (*19).*

Japanese trees as tsunami debris

Five Japanese trees (spruce, fir, and Japanese black pine (*4*) were detected between 2013 and 2016 in Washington and Oregon (table S2: BF-56, 160, 264, 501, 651); while some arriving trees were doubtless overlooked, especially amongst the extensive wood debris typical of Pacific Northwest beaches, veteran beachcombers and beach walker naturalists readily detected and alerted us to these allochthonous trees. As with the post-and-beam wood and milled logs (table S1), all trees were heavily bored by teredinid bivalve mollusks ("shipworms"), eight species of which were found in the wood debris (table S2A, S2B). Species diversity was low on these trees: four trees (BF-56, 160, 501, 651) had 0-5 living species (mean 2.5 ± 2.4); one tree (BF-264) had 16 species (see data base reference in Acknowledgments). Only one species, a bryozoan (*Cauloramphus* sp., represented by a dead colony, BF-160) was unique to trees.

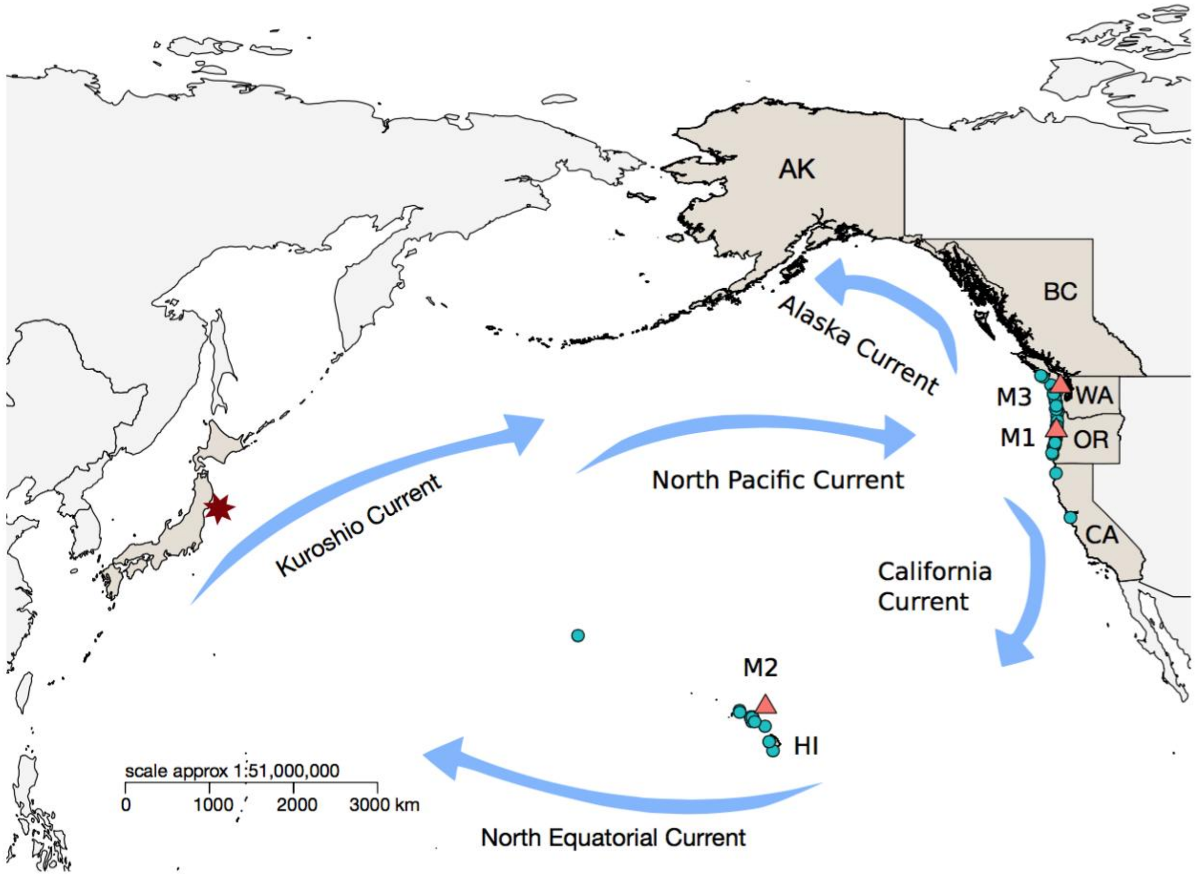

Fig. S1. Major components of the North Pacific Ocean gyre current system that influenced aspects of the dispersal of debris originating from the East Japan Earthquake and Tsunami. The **red star** indicates the earthquake epicenter in Japan. The **cyan dots** are landing sites of JTMD vessels which were assigned BF numbers (*4*); additional vessels landed from Alaska to California and in Hawai‘i for which biological samples were not available. The single dot in the Central Pacific northwest of the Hawaiian Islands represents a vessel (JTMD-BF-152, Table S1) from Miyagi Prefecture landing on Eastern Island, Midway. The **red triangles** show the landing or detection locations of three of four identical fisheries docks lost from the Port of Misawa, Aomori Prefecture, northeast Honshu, on March 11, 2011. Each dock (made of steel, concrete, rubber, plastic, and other materials, and filled in part with prestressed solid polystyrene) measured 20.1 m in length, 5.8 meters in width, and 2.1 meters in height, and weighed approximately 170 metric tons. ***M1*** (Misawa fisheries dock 1, so numbered because it was the first dock found (Figure 1A)) was seen traveling south close to the Oregon coast on June 4, 2012 prior to landing on Agate Beach, approximately 3 km north of Newport OR (Lincoln County) on June 5, having been carried east from Japan perhaps south of the Aleutian Islands. ***M2*** **(**Misawa dock 2) was seen drifting to the west in the open ocean past the Hawaiian islands of Maui and then Moloka‘i between September 17 and 19, 2012, but has not been seen since. ***M3*** (Misawa 3) was first observed on December 14, 2012, drifting to the north in the open ocean approximately 30 km northwest of Grays Harbor, Washington (Grays Harbor County) before being found ashore near Mosquito Creek, Jefferson County, Washington, in Olympic National Park, on December 18. The fourth Misawa dock has not been reported adrift or ashore anywhere as of August 2017. The history of the three detected docks underscores the challenges in predicting or reconstructing specific rafting (transport) routes of JTMD, given that these three objects began their ocean drift at the same time from the same location: one dock appeared in North America drifting south 14.5 months after loss, while a second dock arrived in the same general region 21 months after loss, drifting north, having been delayed en route, or on a more circuitous yet unknown route, for more than 6 months; in between M1 and M2, a third dock, on a distinctly different but also unpredictable trajectory, was seen drifting west through the Central Pacific toward Asia 18 months after loss. While some objects were turned south and then *continued back west* in the Central Pacific (such as Misawa 2) and did not proceed east to North America, other objects travelled through similar southern waters and yet *continued east:* a vessel (JTMD-BF-226; Table S1) from Miyagi Prefecture landed on the central coast of Washington in May 2014 with the warmer water neustonic (oceanic) bryozoan *Jellyella eburnea* (*54)* in the vessel biofouling, indicating an eastward track in lower latitudes of the Northern Hemisphere before being transported perhaps 20 or more degrees in latitude to the north and east. Japanese tsunami marine debris appears to have been subject to a complex history of dispersal directions and long-term tracks resulting in a diverse patterns of landings in North America and the Hawaiian Islands since 2012. This history is presumably linked to the combined variables of the specific physical characteristics of given drifting objects (some of which were increasingly burdened by increased drag due to substantial growths of the pelagic gooseneck barnacle *Lepas* spp.) and the interplay of fluctuating surface wind cells and ocean currents (including the major currents shown in this figure as well as convergence zones, eddy fields, and recirculation gyres; *54*).

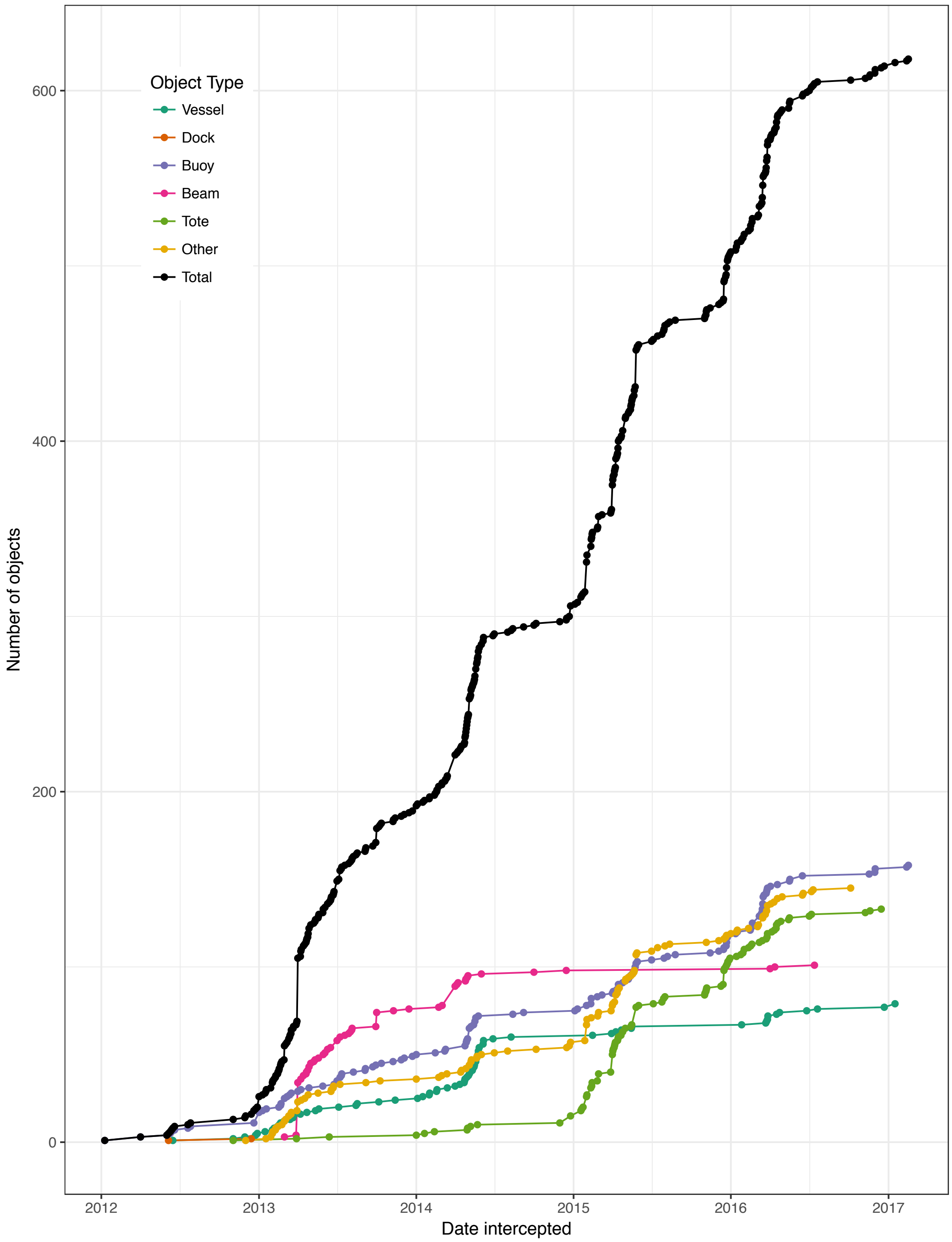

Fig. S2. Cumulative landings of Japanese tsunami marine debris objects by date. Object details as in Fig. 2 caption. Post-and-beam pieces detected in 2016 may represent re-drift (washed back out to sea after earlier landings), rather than being at sea since 2011. Strong spring pulses of JTMD landings are evident in all years.

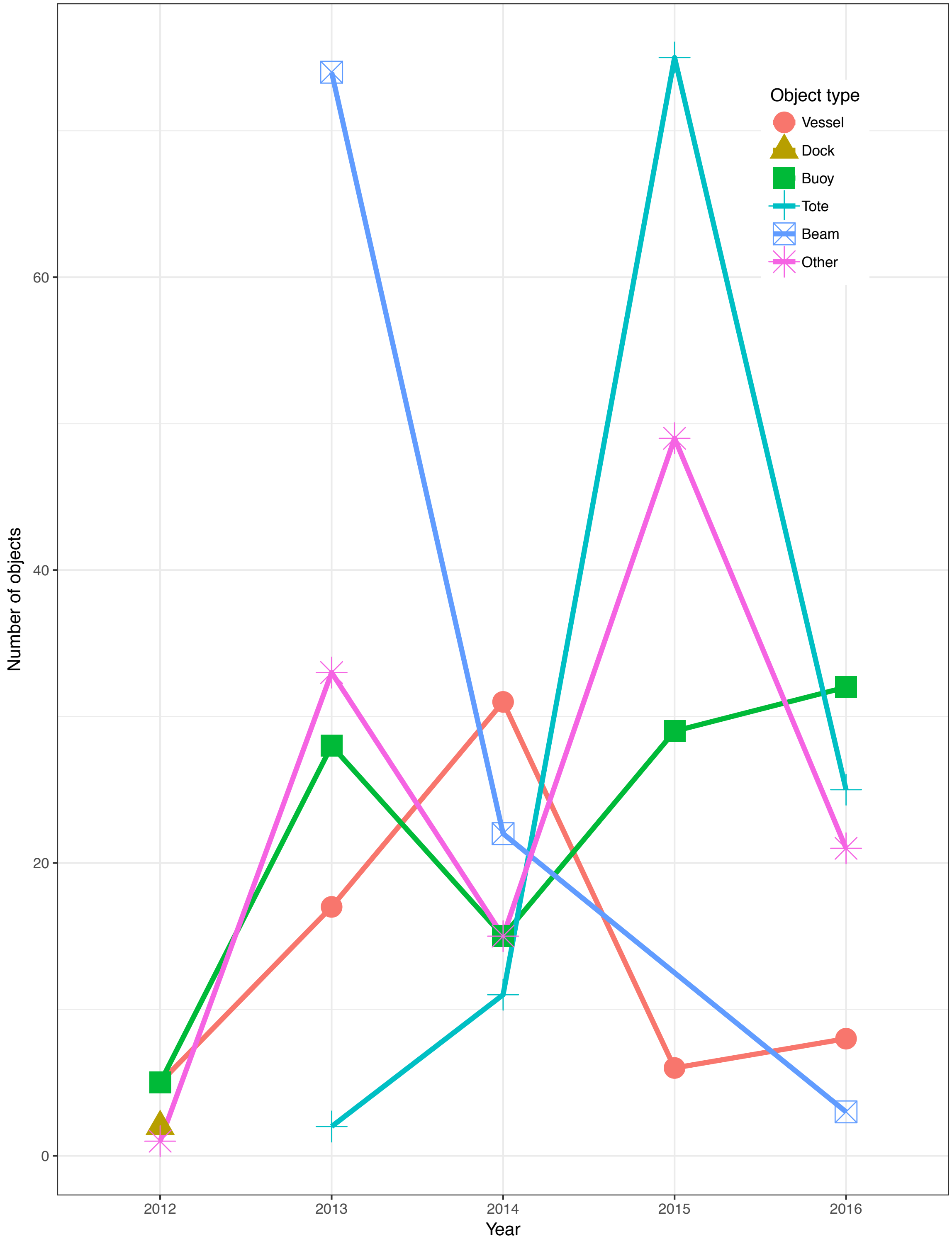

Fig. S3. Frequency of JTMD objects averaged by year, 2012-2016. Data shown as annual summations, and thus 2017 (for which data are available only through February) is not shown. Object details as in Fig. 2 caption. Post-and-beam details as in Fig. 2 and Fig. S2 captions.

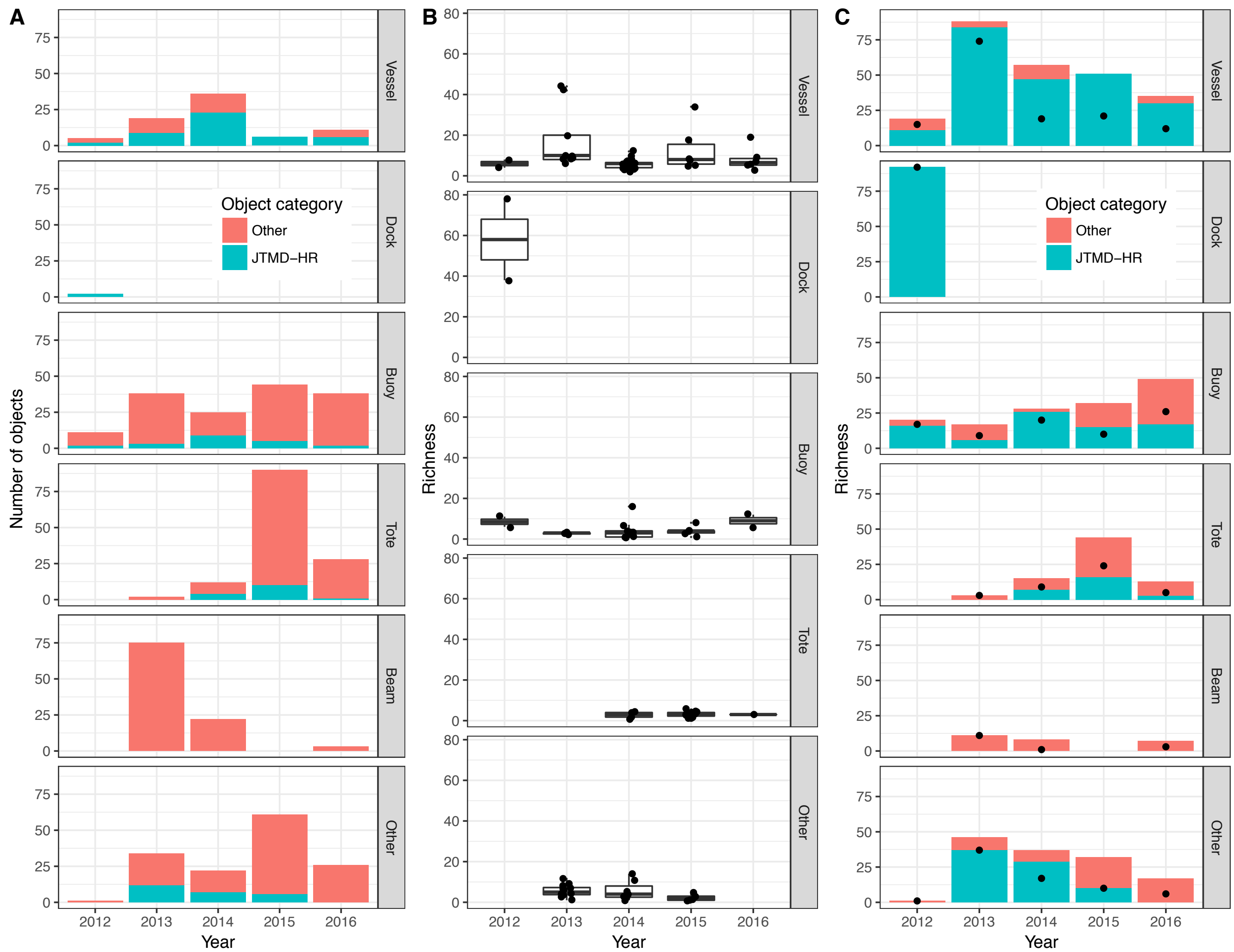

Fig. S4. Detailed summary of temporal distribution of JTMD higher resolution (HR) and total landings for objects detected by year, number, and richness. Object explanations as in Fig. 2 caption. (A) Number of objects between 2012 and 2016. Data shown as annual summations, and thus 2017 (for which data are available only through February) is not shown. Higher Resolution objects (see text and note *4*) shown in blue. (B) Quartile distribution of species diversity (richness) for JTMD-HR landings by object type. No post-and-beams were JTMD-HR. (C) Total cumulative richness per year by object type. JTMD-HR objects (see text and note *4*) shown in blue. The dots represent the number of unique taxa added in each successive year within each object type (for JTMD-HR and total landings combined), exclusive of those species detected in previous years.

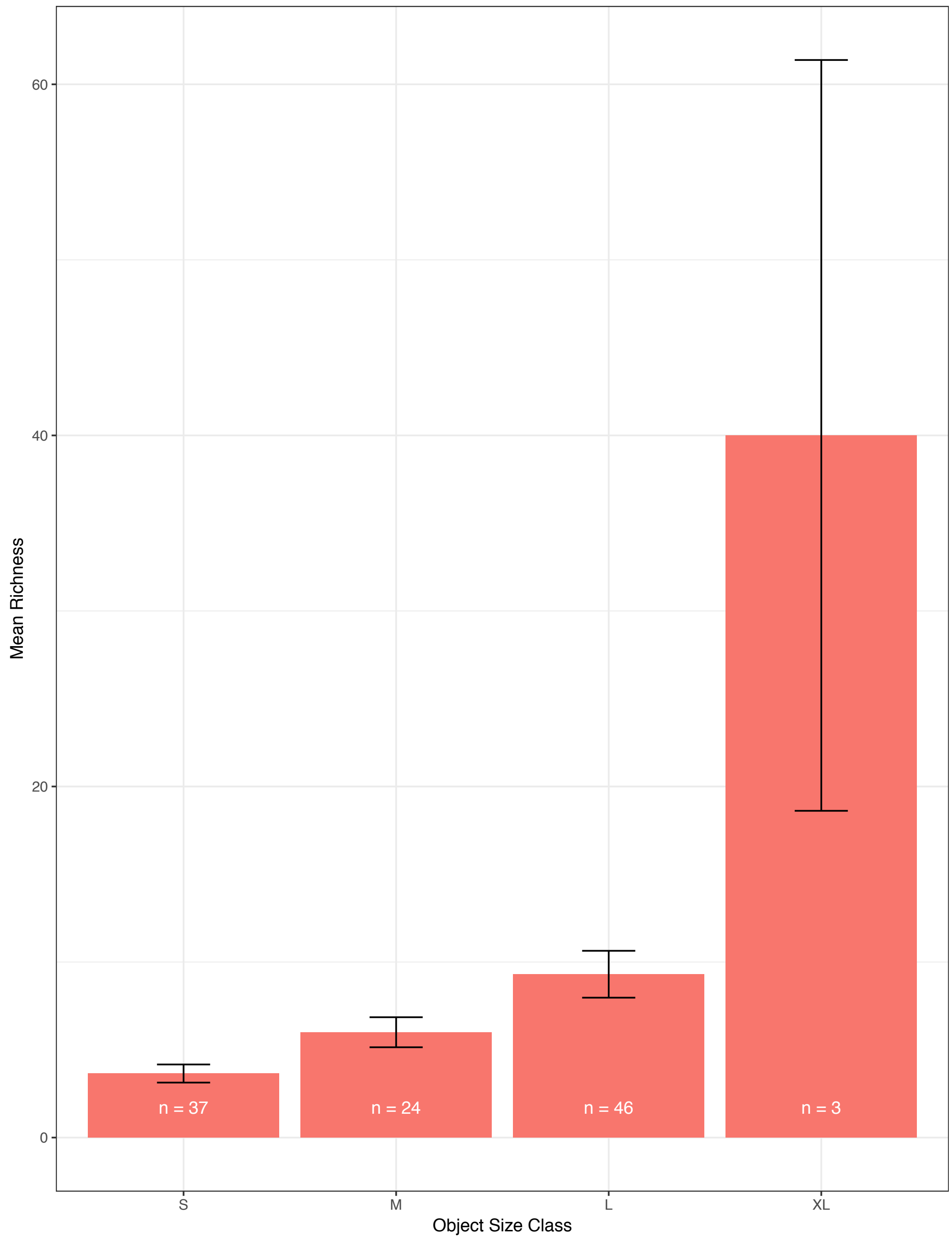

Fig. S5. Mean Japanese macroinvertebrate and fish richness of JTMD higher resolution (HR) objects (*4*) shown as object size classes. S, small; M, medium; L, large; XL, extra large. Size class definitions in *(4)*. "n" is number of objects in each size class. Error bars represent 1 SE. See Fig. S5 for significance comparisons.

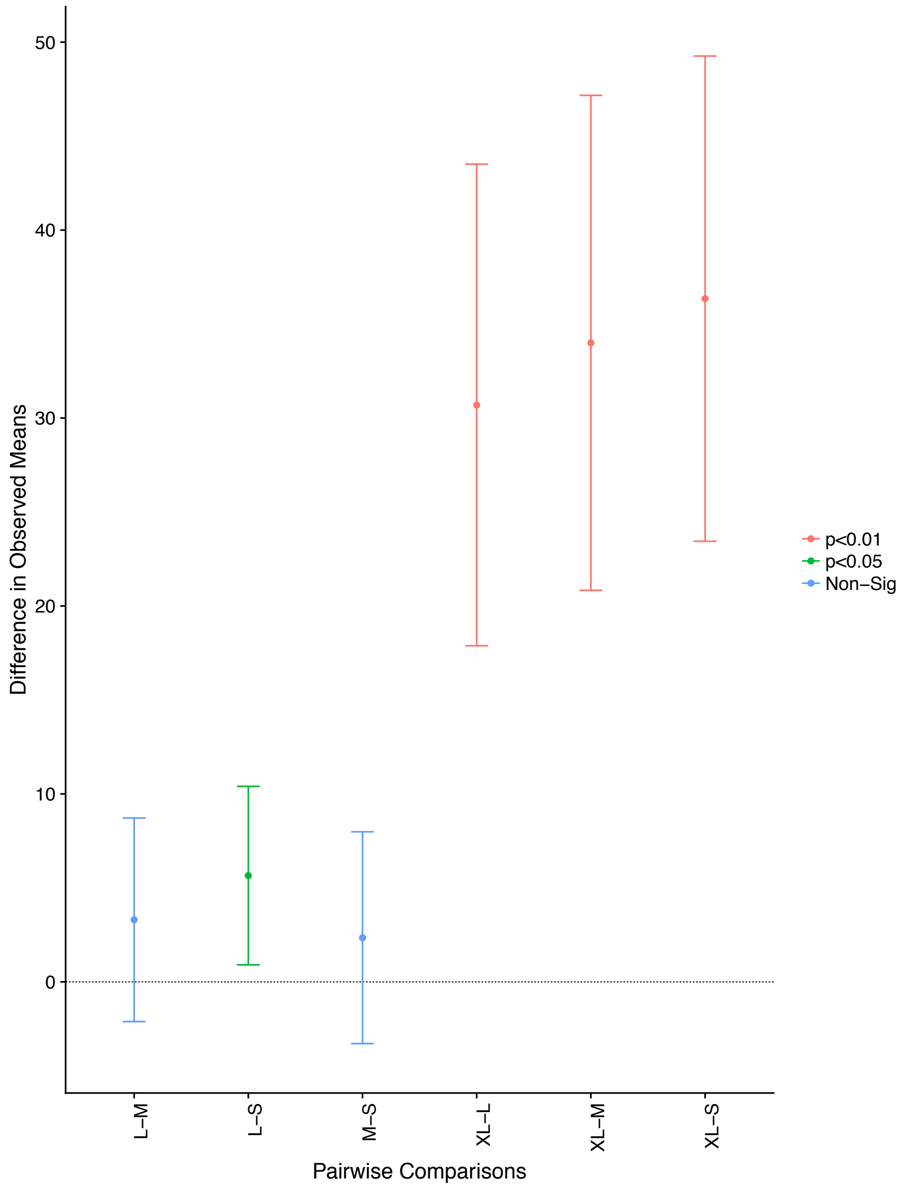

Fig. S6. Differences in observed richness means of Mean Japanese macroinvertebrate and fish richness of JTMD higher resolution (HR) objects (*4*) shown as object size classes. S, small; M, medium; L, large; XL, extra large. Size class definitions in *(4)*. "n" is number of objects in each size class. Error bars represent 1 SE. See Fig. S5 for significance comparisons. Richness of large objects is significantly (p-value 0.01199; Tukey HSD test) different than richness of small objects. Large object richness is not significantly different from medium objects, nor medium from small. Error bars represent 1 SE. As noted in Materials and Methods (*4*), two of the three extra large objects did not exceed medium and large items in diversity, and thus pairwise comparisons are made only between small, medium, and large objects.

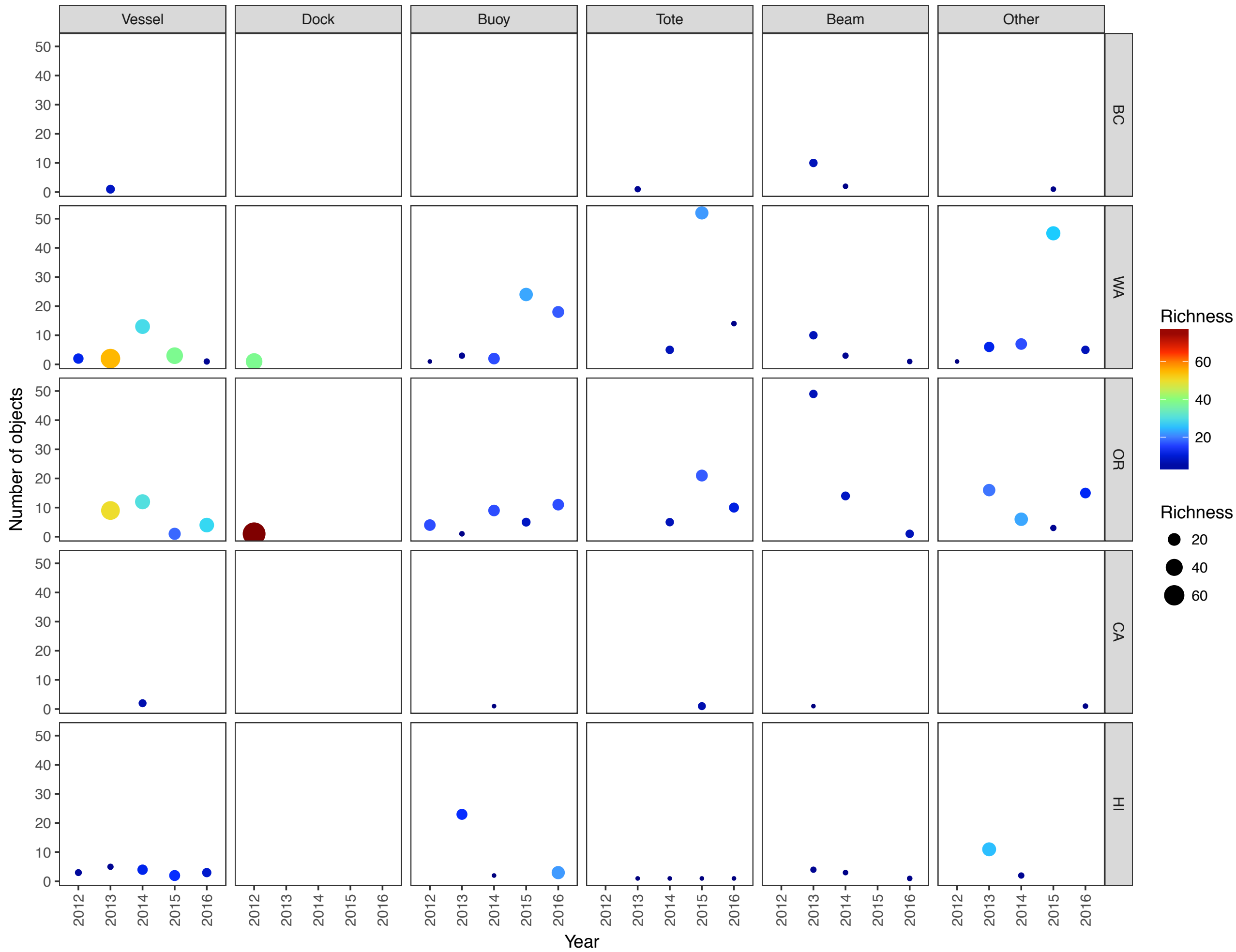

Fig. S7. Geography and temporal distribution of number of landings and living Japanese macroinvertebrate and fish species richness detected by object type, year, and location. Data shown as annual summations, and thus 2017 (for which data are available only through February) is not shown. Richness and landing data are for all objects and not restricted to JTMD-HR landings. Most objects were intercepted in Washington and Oregon. Biofouled object landings in British Columbia (shown) and Alaska (excluded here due to limited number (n=2 total across all years and types); see fig. S8) are underestimated due to extensive inaccessible coastlines and reduced search effort. California received fewer JTMD objects than the Pacific Northwest, with no known biofouled landings south of central California.

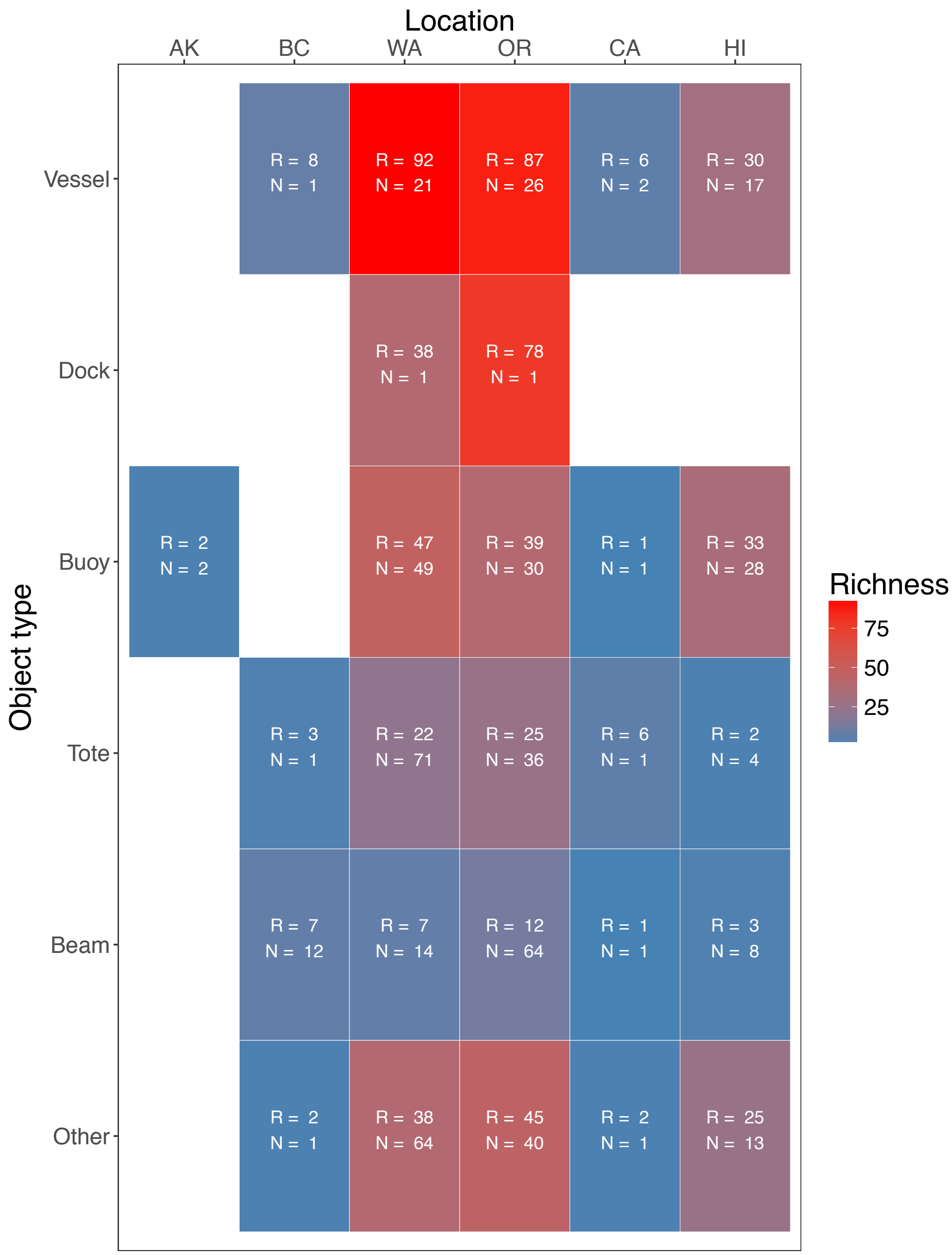

Fig. S8. Details of richness and number of objects by location (states and province). R is total summed species richness and N is total object number, for each object type by location. For example, there was one dock landing in Oregon (JTMD-BF-1) with 79 macroinvertebrate species, and one dock landing in Washington (JTMD-BF-8) with 39 macroinvertebrate species.

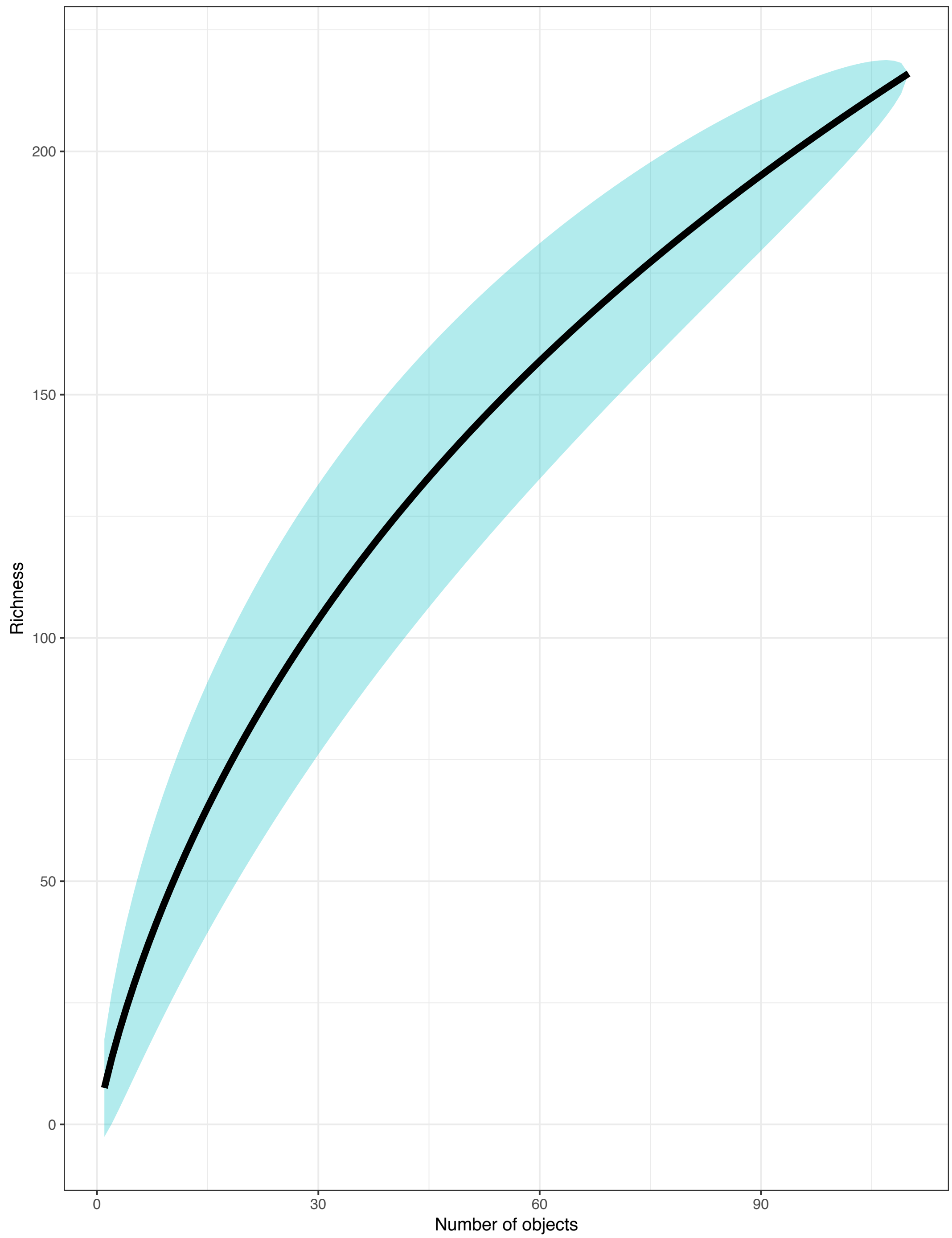

Fig. S9. Rarefaction estimate of total potential JTMD richness. Chao estimator based upon 110 JTMD-HR objects (see text and note *4*) supporting 207 species, yielding a total species pool (maximum estimated species richness) estimate of 357 ± 41 species (estimators shown in table S4). Shaded area represents 95% confidence intervals.

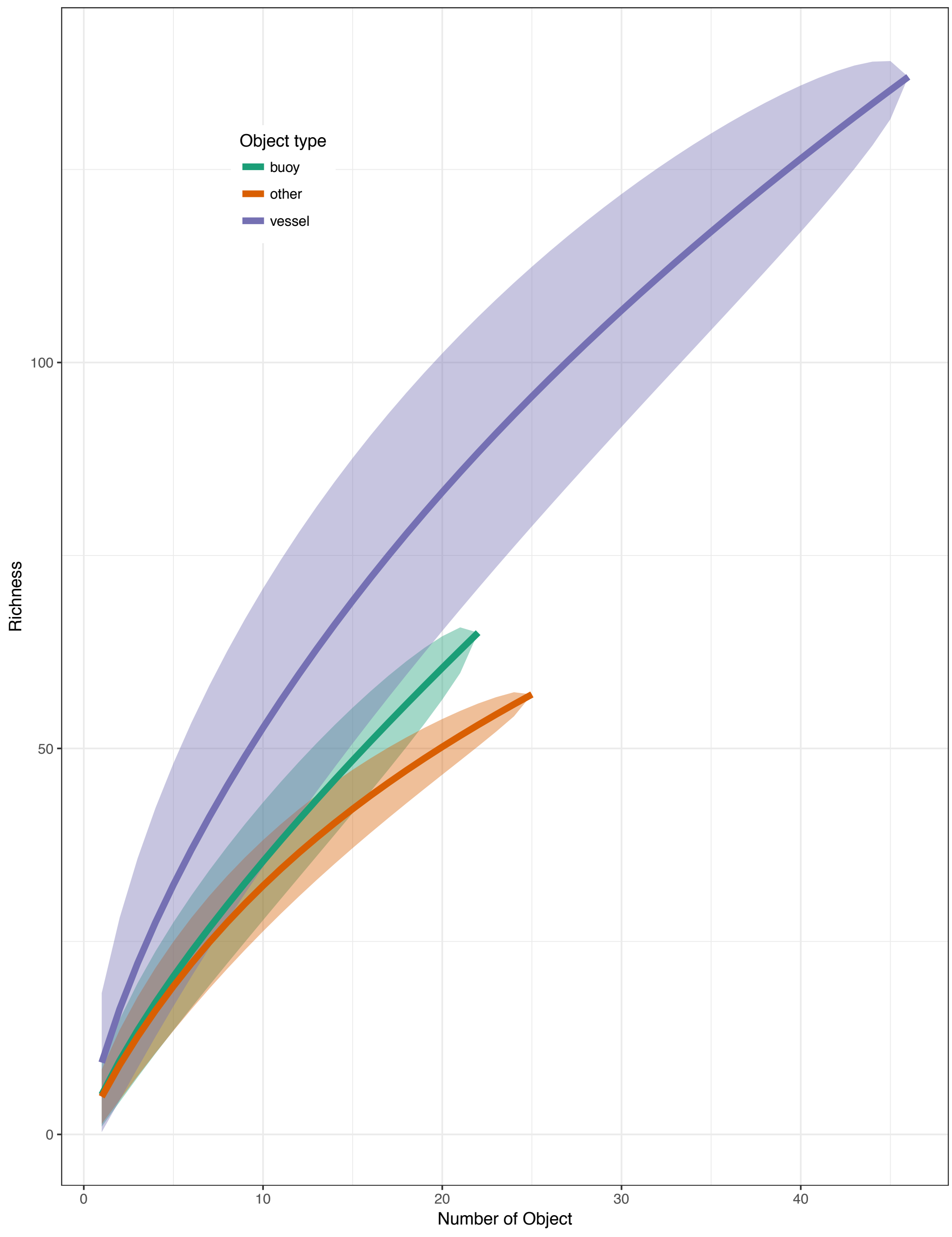

Fig. S10. Rarefaction estimate of total potential JTMD richness. Chao estimators based upon JTMD-HR buoys, vessels, and other objects (as detailed in Fig. 2 caption). Estimators shown in table S4. Shaded area represents 95% confidence intervals.

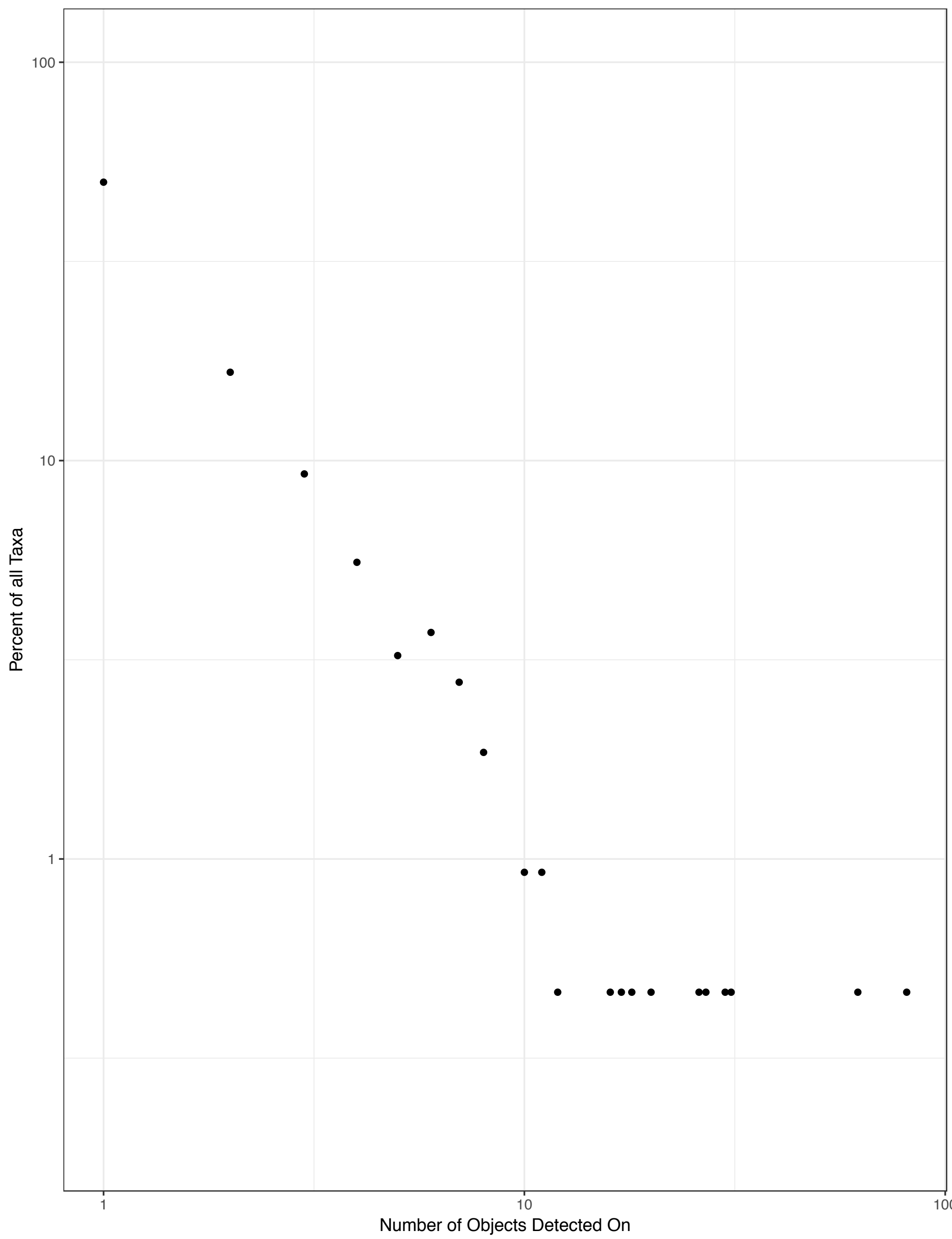

Fig. S11. Frequency of occurrence for all macroinvertebrate and fish taxa on objects. Shown is the percent of JTMD-HR species detected as a function of number of objects on which they were detected. Over half of all species were only detected on one object. Log scale plot of JTMD-HR objects (n= 110).

Table S1.

Register of sampled Japanese Tsunami Marine Debris (JTMD) objects: BF (Biofouling) numbers, landing site locations, latitude x longitude in decimal degrees, date, and object type; prefecture and city of origin if known.

Some earlier numbered items (not shown) were later removed from the database as not meeting JTMD-BF-criteria (note *4*); thus, while the item numbers shown go up to 679, only 634 objects were analyzed for this study. Some sites (such as the Long Beach Peninsula WA, Ocean Shores Peninsula WA and the Cape Blanco OR region) are several to many kilometers in length, and thus a site with the same name may have slightly different coordinates. Post-and-beam wood dates are actual or best estimated landing dates (occasionally set as a standard date based upon forensic evidence and site familiarity). Object metadata are at dryad accession site provided in Acknowledgments.

* = JTMD-HR: JTMD objects most thoroughly sampled (Higher Resolution) for macrobiota diversity (*4*).

JTMD-BF-	State or Province	Location	Latitude	Longitude	Date	Object	Prefecture (and city) origin in Japan
*1	OR	Agate Beach, near Newport	44.66455	-124.061158	5 June 2012	dock	Aomori: Misawa
*2	WA	Ilwaco	46.302406	-124.037256	15 June 2012	vessel	Miyagi
3*	OR	in ocean off Lincoln City	44.92825 (estimate)	-124.045969 (estimate)	9 June 2012	buoy	
4	OR	in ocean 85 km off Alsea Bay	44.418397	-124.922792	June 2012	buoy	
5	CA	Bodega Bay: Salmon Creek Beach	38.204659	-123.041335	19 June 2012	float	
*6	HI	Oahu: Kahana Bay	21.556689	-157.874972	29 November 2012	vessel	Iwate: Ofunato
7	OR	in ocean off Newport	44.614878 (estimate)	-124.195000 (estimate)	12 June 2012	float	
*8	WA	Olympic National Park: near Mosquito Creek	47.798108	-124.482242	18 December 2012	dock	Aomori: Misawa
9	WA	Olympic National Park: near Mosquito Creek	47.798108	-124.482242	20 December 2012	float	
10	WA	Olympic National Park: near Mosquito Creek	47.798108	-124.482242	20 December 2012	float	
11	HI	Oahu: Punaluu	21.591161	-157.890456	24 December 2014	vessel	Miyagi

12	WA	Grays Harbor: Damon Point	46.931561	-124.100528	28 December 2012	vessel	
13	WA	Olympic National Park: near Mosquito Creek	47.800236	-124.483256	20 July 2012	buoy	
14	CA	16km north of Fort Ross	38.596853	-123.350833	1 April 2012	float	
15	CA	in ocean off Ft. Ross	38.460178 (estimate)	-123.355556 (estimate)	26 July 2012	buoy	
16	Midway	Eastern Island	28.205808	-177.336394	2 November 2012	tote	
*17	HI	Oahu: Hanauma Bay	21.271094	-157.696808	9 January 2013	buoy	
*18	OR	Clatsop Beach	46.188033	-123.989461	9 January 2013	dock fender	
19	HI	Hawai‘i: Honokohau	19.676731	-156.026666	9 January 2013	float	
*20	HI	Oahu: Mokuleia	21.582003	-158.206703	17 January 2013	metal cylinder	
21	HI	Kauai: in ocean off Nohili Point	22.064383 (estimate)	-159.783819 (estimate)	18 January 2013	navigation buoy	Fukushima: Onahama
22	WA	Ocean City State Park	46.983494	-124.174953	2 February 2013	refrigerator	
*23	OR	Gleneden Beach	44.889214	-124.035278	5 February 2013	vessel	
*24	OR	Newport: South Beach	44.607683	-124.0687	8 February 2013	pallet	
25	HI	Oahu: Kahuku	21.683367	-157.944247	13 February 2013	vessel	Miyagi
*27	HI	Oahu: Makapuu Beach	21.311108	-157.66005	14 February 2013	pontoon section	
*28	OR	Horsfall Beach	43.454106	-124.277689	20 February 2013	vessel	Miyagi
29	OR	Clatsop Beach	46.188033	-123.989461	27 February 2013	vessel	Iwate
30	OR	Lincoln City: Road’s End	45.008075	-124.009661	28 February 2013	vessel	
31	HI	Oahu: Laie	21.648639	-157.922369	4 March 2013	rope	
*32	HI	Maui: Ahihi Kinau	20.600631	-156.437	11 March 2013	pontoon section	
33	HI	Oahu: Kahalu’u	21.457827	157.830000	7 March	buoy	

					2013		
34	HI	Kauai: Lepeuli Beach	22.207492	-159.338625	20 February 2013	ropes/ buoys	
35	HI	Oahu: Kahuku	21.683367	-157.944247	21 February 2013	buoy	
36	OR	Florence: Muriel Ponsler Wayside	44.169722	-124.117383	14 March 2013	vessel	
*37	WA	Olympic National Park	47.798108	-124.482242	17 March 2013	box	
38	OR	Cape Arago: Lighthouse Beach	43.338936	-124.372622	17 March 2013	buoy	
*39	OR	Cannon Beach	45.892186	-123.964725	21 March 2013	vessel	Fukushima
*40	WA	Long Beach Peninsula	46.475511	-124.071969	22 March 2013	vessel	Iwate: Rikuzentaka -ta
41	HI	Maui: Kahoolawe: Kanapou	20.546353	-156.553056	13 March 2013	buoy	
*42	OR	Lincoln City: Salishan	44.889214	-124.035278	9 April 2013	log	
*43	OR	Lincoln City: Camp Westwind	45.038608	-124.006022	7 April 2013	vessel	
44	BC	Ucluelet	48.9367	-125.552303	28 March 2013	post-and-beam wood	
45	BC	Ucluelet	48.9367	-125.552303	8 April 2013	post-and-beam wood	
46	BC	Ucluelet	48.9367	-125.552303	8 April 2013	post-and-beam wood	
47	OR	Nye Beach	44.642333	-124.063011	14 April 2013	post-and-beam wood	
48	OR	Nye Beach	44.642333	-124.063011	14 April 2013	post-and-beam wood	
49	HI	Oahu: Lanikai Beach	21.393008	-157.715328	29 March 2013	container	
*50	OR	Coos Bay: north spit	43.411944	-124.300539	22 April 2013	vessel	
51	OR	Coos Bay: north spit	43.411944	-124.300539	25 April 2013	pallet	
52	OR	Coos Bay: north spit	43.411944	-124.300539	25 April 2013	pallet	
53	BC	Ucluelet	48.9367	-125.552303	April 2013	post-and-beam wood	
54	HI	Hawaiʻi: Kamilo Point Beach	18.974297	-155.597222	8 April 2013	Float	
55	OR	Moolack	44.699717	-124.0636	11 May	post-and-	

		Beach			3013	beam wood	
56	OR	Newport: South Beach	44.607683	-124.0687	17 April 2013	tree	
57	OR	Newport: South Beach	44.607683	-124.0687	8 May 2013	post-and-beam wood	
*58	OR	Clatsop Beach	46.188033	-123.989461	30 May 2013	vessel fragment	
59	OR	Nye Beach	44.642333	-124.063011	30 May 2013	post-and-beam wood	
60	OR	Tillamook Bay: Ocean Beach	45.561572	-123.952322	19 May 2013	post-and-beam wood	
61	OR	Nye Beach	44.642333	-124.063011	30 May 2013	post-and-beam wood	
63	WA	Grayland Beach North	46.805672	-124.105000	21 April 2013	post-and-beam wood	
64	OR	Yaquina Head	44.675583	-124.077778	3 June 2013	post-and-beam wood	
65	OR	between Lost Creek and Thiel Creek	44.552100	-124.075556	9 June 2013	post-and-beam wood	
66	OR	between Lost Creek and Thiel Creek	44.552100	-124.075556	9 June 2013	post-and-beam wood	
*67	OR	Cape Arago: North Cove	43.307539	-124.399283	18 June 2013	pallet	
68	HI	Hawai‘i: Kamilo Point	18.974297	-155.597222	February 2013	refrigerator	
69	HI	Hawai‘i: Kamilo Point	18.974297	-155.597222	16 March 2013	refrigerator	
70	HI	Hawai‘i: Kamilo Point	18.974297	-155.597222	23 June 2013	TV set	
*71	WA	Olympic National Park	47.800236	-124.483256	23 June 2013	pallet	
72	HI	Oahu: Punaluu	21.591161	-157.890456	17 June 2013	I-beam	
73	OR	Coos County: Whiskey Run Beach	43.2163167	-124.396944	8 July 2013	piling	
74	OR	Coos County: Whiskey Run Beach	43.2163167	-124.396944	8 July 2013	post-and-beam wood	
75	HI	Oahu: Laie: Malaekahana Beach	21.668564	-157.936668	5 July 2013	vessel	Iwate
76	AK	Kenai Fjords National Park	59.846864	-149.595081	24 June 2013	buoy	
77	BC	Vancouver Is: between Bamfield and	48.627503	-124.771111	13 June 2013	box	

		Port Renfrew					
78	WA	Makah Reservation	48.329967	-124.664167	12 May 2013	vessel	Aomori
79	OR	Bandon region	43.115111	-124.436436	winter-summer 2013	buoy	
80	OR	Bandon	43.115111	-124.436436	winter-summer 2013	buoy	
81	OR	Bandon	43.115111	-124.436436	winter-summer 2013	pallet	
*82	OR	Coos Bay region	43.216942	-124.396583	30 March 2013	board	
83	BC	Vancouver Is.: Turret Is.	48.895589	-125.338889	18 May2013	plastic bottle	
84	HI	Oahu: James Campbell NWR	21.697456	-157.955556	week of July 8 2013	buoy	
85	HI	Oahu: James Campbell NWR	21.697456	-157.955556	week of July 8 2013	buoy with rope	
86	OR	North of Cape Sebastian: Kissing Rock	42.386447	-124.424722	4 August 2013	post-and-beam wood	
87	HI	Oahu: Kawela	21.700403	-158.006547	14 August 2013	vessel	Miyagi
88	HI	Oahu: Turtle Bay Resort	21.705314	-157.997778	17 August 2013	vessel	
89	OR	Tillamook Co.: Bay Ocean Peninsula	45.561572	-123.952322	28 July 2013	post-and-beam wood	
*90	HI	Hawai‘i: in ocean off Keauhou	19.575356 (estimate)	-155.991675 (estimate)	4 September 2013	buoy	
91	HI	in ocean 1.6 km off Kona coast	19.341684	-155.585672	5 September 2013	buoy	
92	HI	Hawai‘i: Kamilo	19.951283	-155.855347	12 July 2013	buoy	
93	AK	Sitka area: SSSC/ Cherokee, Yamani area	56.669294	-135.197222	8 August 2013	buoy	
94	BC	Ucluelet	48.9367	-125.552303	winter-spring 2013	vessel	
95	BC	Ucluelet area	48.9367	-125.552303	winter-spring 2013	vessel fragment	

96	HI	Maui: Au‘au channel	20.780583	-156.73545	22 September 2013	buoy	
97	WA	Long Beach Peninsula	46.475511	-124.071969	20 April 2013	post-and-beam wood	
103	OR	Bandon region	43.115111	-124.436436	late 2012 to early 2013	buoy	
104	OR	Bandon region	43.115111	-124.436436	late 2012 to early 2013	buoy	
105	OR	Bandon	43.115111	-124.436436	1 January 2013	buoy	
106	OR	Cape Blanco	42.838236	-124.561644	11 July 2013	buoy	
107	OR	Whiskey Run Beach	43.2163167	-124.396944	8 July 2013	post-and-beam wood	
108	OR	Cape Arago: Lighthouse Beach	43.338936	-124.372622	11 July 2013	post-and-beam wood	
109	OR	Cape Arago: Lighthouse Beach	43.338936	-124.372622	13 July 2013	post-and-beam wood	
110	BC	Ucluelet	48.9367	-125.552303	spring 2013	post-and-beam wood	
111	BC	Ucluelet	48.9367	-125.552303	spring 2013	post-and-beam wood	
114	OR	Rocky Point, south of Port Orford	42.719197	-124.467778	19 July 2013	post-and-beam wood	
116	OR	Crook Point, south of Gold Beach	42.25125	-124.412772	1 July 2013	post-and-beam wood	
117	OR	Brookings: Lone Ranch State Park	42.0982194	-124.343056	5 August 2013	post-and-beam wood	
118	OR	Cape Arago: South Cove	43.303531	-124.396389	August 2013	post-and-beam wood	
119	OR	Pistol River, south of Gold Beach	42.277378	-124.408819	1 April 2013	post-and-beam wood	
120	OR	North Cove, Cape Arago	43.307539	-124.399283	1 April 2013	post-and-beam wood	
121	OR	Cape Arago: North Cove	43.307539	-124.399283	1 April 2013	post-and-beam wood	
123	OR	Cape Arago: North Cove	43.307539	-124.399283	1 April 2013	post-and-beam wood	
124	OR	Crook Point, south of Gold Beach	42.25125	-124.412772	1 July 2013	post-and-beam wood	

125	OR	Lost Creek, south of Newport	44.551983	-124.073486	1 October 2013	post-and-beam wood	
126	OR	Newport: Agate Beach	44.66455	-124.061158	1 July 2013	post-and-beam wood	
127	OR	Crook Point, south of Gold Beach	42.25125	-124.412772	1 July 2013	post-and-beam wood	
128	OR	Bandon	43.115111	-124.436436	2 March 2014	post-and-beam wood	
*129	BC	Long Beach Peninsula	49.067658	-125.753644	6 October 2013	vessel	
*130	OR	Clatsop Beach	46.188033	-123.989461	9 October 2013	pontoon section	
*131	WA	Between Grayland Beach State Park and Tokeland	46.750892	-124.096014	13 November 2013	vessel	
132	HI	Maui: Au‘au channel between Maui and Lana‘i	20.851781	-156.744167	27 November 2013	buoy	
133	HI	Maui: Au‘au channel between Maui and Lana'i	20.851781	-156.744167	4 December 2013	buoy	
*134	WA	Westport: Twin Harbors State Park	48.857367	-124.108597	16 January 2014	vessel	Miyagi
*135	OR	Yachats	44.335344	-124.099811	17 February 2014	vessel	
136	OR	Newport: South Beach	44.607683	-124.0687	22 February 2014	lid	
137	OR	Newport: South Beach	44.607683	-124.0687	22 February 2014	post-and-beam wood	
138	HI	Kamilo Beach	18.974297	-155.597222	late January 2014	post-and-beam wood	
*139	HI	Pearl Harbor: Hickam Field	21.317361	-157.960361	18 February 2014	vessel	Miyagi
140	WA	Long Beach Peninsula: Leadbetter Point	46.475511	-124.071969	December 2012	cooler	

141	WA	Long Beach Peninsula	46.475511	-124.071969	March 2013	lid	
142	HI	Oahu: Hanauma Bay	21.271094	-157.696808	29 May 2013	buoy	
143	HI	Oahu: Kailua Beach	21.405117	-157.738383	6 September 2013	pallet	
144	HI	Kauai: Waipake-Lepeuli	22.207492	-159.338625	29 September 2013	buoy	
145	HI	Oahu: Maunalua Bay	21.258203	-157.744394	12 October 2013	buoy	
147	HI	Kauai: Hanamaulu Beach Park	21.993161	-159.340833	8 November 2013	lighted marine buoy	
148	HI	Maui: Kalepa Gulch: Waihee	20.935936	-156.506111	February 2014	vessel	
149	HI	Kauai: Waipake Beach	22.207492	-159.338625	27 April 2013	buoy	
150	OR	Cape Arago: North Cove	43.307539	-124.399283	1 October 2013	post-and-beam wood	
152	Midway	Eastern Island	28.205808	-177.336394	2 November 2012	vessel	Miyagi
153	Midway	Eastern Island	28.205808	-177.336394	16 February 2013	buoy	
*154	Midway		28.205808	-177.336394	2012-2013	buoy	
155	Midway	Eastern Island	28.205808	-177.336394	14 February 2014	buoy	
156	Midway		28.205808	-177.336394	2012-2013	buoy	
157	OR	Newport: South Beach	44.607683	-124.0687	1 October 2013	post-and-beam wood	
158	HI	Oahu: Malaekahana Beach Park	21.668564	-157.936668	12 February 2014	box	
159	OR	Cape Arago: South Cove	43.303531	-124.396389	16 June 2013	post-and-beam wood	
*160	OR	Cape Meares: Tillamook Bay spit	45.524289	-123.955261	26 April 2014	tree	
161	OR	Newport: North Jetty	44.615053	-124.073889	1 October 2013	post-and-beam wood	
163	OR	Otter Rock	44.746533	-124.062978	1 October 2013	post-and-beam wood	
164	OR	Otter Rock	44.746533	-124.062978	5 April 2014	post-and-beam wood	

165	OR	Ophir: Woodruff Creek	42.588292	-124.396944	May 2013	post-and-beam wood	
167	OR	Crook Point, south side	42.25125	-124.412772	1 April 2013	post-and-beam wood	
*168	WA	Long Beach Peninsula	46.475511	-124.071969	10 March 2014	buoy	
*170	WA	Long Beach Peninsula	46.475511	-124.071969	23 April 2014	vessel	
171	OR	Tillamook	45.561572	-123.952322	25 April 2014	post-and-beam wood	
*172	OR	Newport: South Beach	44.607683	-124.0687	27 April 2014	buoy	
*173	OR	Newport: South Beach	44.607683	-124.0687	27 April 2014	buoy	
174	OR	Yaquina Bay, beach at Hatfield Station	44.623867	-124.045278	26 April 2014	post-and-beam wood	
176	OR	Newport: South Beach	44.607683	-124.0687	29 April 2014	post-and-beam wood	
*177	WA	Ocean City State Park: Ocean Shores	46.983494	-124.174953	28 April 2014	vessel	
179	BC	Ucluelet area: Salmon and Beach	48.9367	-125.552303	9/10 March 2014	post-and-beam wood	
180	BC	Ucluelet area: Broken Group Islands	48.873264	-125.369445	8 April 2014	post-and-beam wood	
181	WA	Long Beach Peninsula	46.475511	-124.071969	March 2013	buoy	
182	WA	Long Beach Peninsula	46.475511	-124.071969	March 2013	post-and-beam wood	
183	WA	Long Beach Peninsula	46.475511	-124.071969	24 April 2014	buoy	
184	WA	Long Beach Peninsula	46.475511	-124.071969	24 April 2014	buoy	
186	OR	Lost Creek, South Beach, 118th Street	44.551983	-124.073486	30 April 2014	tote	
187	AK	Catherine Island, Chatham Strait	57.3224556	-134.812778	30 April 2014	buoy	
*188	OR	Cape Lookout	45.356672	-123.973058	2 May 2014	vessel	
189	OR	Cape Lookout Beach	45.356672	-123.973058	4 May 2014	buoy	
190	OR	Cape Lookout Beach	45.356672	-123.973058	4 May 2014	propane tank	
191	OR	Cape Lookout	45.356672	-123.973058	4 May	plastic	

		Beach			2014	fragment	
192	OR	Cape Lookout Beach	45.356672	-123.973058	4 May 2014	buoy	
193	OR	Cape Lookout Beach	45.356672	-123.973058	4 May 2014	buoy	
*196	OR	Waldport	44.439411	-124.084272	11 May 2014	vessel	
*197	OR	Quinault	47.400867	-124.330544	9 May 2014	pontoon section	
*198	OR	Sand Lake: Tierra del Mar	45.253539	-123.969358	12 May 2014	vessel	
*199	OR	north of Umpqua River	43.783216	-124.174530	15 May 2014	vessel	
200	OR	Rockaway: Manzanita State Park	45.720494	-123.945572	April 2012	buoy	
*201	OR	Brian Booth State Park	44.528783	-124.076225	16 May 2014	vessel	
*202	OR	Surfland	44.580408	-124.069608	16 May 2014	vessel	
203	WA	Long Beach Peninsula	46.475511	-124.071969	April 2013	buoy	
*205	HI	Kauai: Larsen's / Lepeuli Beach	22.206567	-159.338425	12 April 2014	vessel	Miyagi
206	HI	Oahu: Waimanalo	21.328933	-157.689167	16 April 2014	propane tank	
*207	OR	Coos Bay: Charleston	43.345911	-124.321667	17 May 2014	buoy	
*208	OR	Cape Arago: North Cove	43.307539	-124.399283	19 May 2014	vessel	
*209	HI	Oahu: Haleiwa, in ocean	21.810331 (estimate)	-158.317636 (estimate)	19 May 2014	vessel	
*210	OR	Carter Lake	43.854247	-124.160867	21 May 2014	vessel	
211	OR	Tahkenitch Lake region	43.805472	-123.169442	21 May 2014	vessel	
*212	OR	Siuslaw River south jetty	44.015347	-124.139364	21 May 2014	pontoon section	
214	OR	Cape Blanco	42.838236	-124.561644	1 October 2013	post-and-beam wood	
*215	OR	South of Dunes City Tehakenitch campground beach	43.803047	-124.170392	19 May 2014	buoy	
*216	OR	South of Dunes City Tehakenitch campground	43.803047	-124.170392	19 May 2014	buoy	

		beach					
217	OR	Cape Lookout Beach	45.356672	-123.973058	4 May 2014	buoy	
218	OR	Cape Lookout Beach	45.356672	-123.973058	4 May 2014	buoy	
219	OR	Cape Lookout Beach	45.356672	-123.973058	4 May 2014	buoy	
221	OR	Cape Lookout Beach	45.356672	-123.973058	25 May 2014	vessel	
*222	WA	Ocean Park	46.475511	-124.071969	23 May 2014	vessel	Iwate
*223	WA	Long Beach Peninsula	46.475511	-124.071969	24 May 2014	vessel	Miyagi
*224	WA	Long Beach Peninsula	46.475511	-124.071969	24 May 2014	vessel	
225	OR	Strawberry Hill	44.254792	-124.112822	27 May 2014	vessel	Iwate
*226	WA	Ocean City	46.983494	-124.174953	25 May 2014	vessel	Miyagi
*227	WA	Long Beach Peninsula	46.475511	-124.071969	5 June 2014	vessel	
228	WA	Long Beach Peninsula	46.475511	-124.071969	5 June 2014	vessel	
*229	WA	Quinault	47.400867	-124.330544	6 June 2014	vessel	Miyagi
230	WA	Long Beach Peninsula	46.475511	-124.071969	6 June 2014	vessel	Miyagi
231	OR	South of Pistol River State Park	42.259853	-124.409167	1 October 2013	post-and-beam wood	
*232	OR	Port Orford: Humbug Mountain State Park	42.687594	-124.448233	17 May 2014	buoy	
233	OR	Netarts Bay	45.429753	-123.946803	28 June 2014	vessel	
234	OR	Newport: South Beach	44.607683	-124.0687	9 February 2013	propane tank	
235	WA	Long Beach Peninsula: Oysterville	46.551036	-124.061892	1 March 2013	tire	
236	AK	Sitka	57.063358	-135.359564	25 May 2014	buoy	
*237	AK	Sitka	57.063358	-135.359564	24 May 2014	buoy	
239	AK	Sitka	57.063358	-135.359564	2013	buoy	
*240	CA	Daly City: Mussel Rock Beach	37.668644	-122.496175	9 August 2014	vessel	
*241	OR	Cape Meares	45.524289	-123.955261	19 August	helmet	

					2014		
242	HI	Maui: Au‘au channel	20.851781	-156.744167	7 September 2014	buoy	
244	BC	Ucluelet	48.9367	-125.552303	1 April 2013	post-and-beam wood	
245	BC	Ucluelet	48.9367	-125.552303	1 October 2013	post-and-beam wood	
246	BC	Ucluelet	48.9367	-125.552303	1 June 2014	post-and-beam wood	
247	OR	Cape Arago: North Cove	43.307539	-124.399283	15 December 2014	post-and-beam wood	
249	CA	Mendocino Co.: MacKerricher State Park	39.516656	-123.781389	13 August 2014	buoy	
250	CA	Dry Lagoon	41.225081	-124.108608	6 June 2014	vessel	Miyagi
251	BC	Ucluelet	48.9367	-125.552303	28 April 2014	buoy	
252	OR	Cape Blanco north	42.838236	-124.561644	23 May 2014	basket	
253	HI	Oahu: Kahana Bay	21.556536	-157.874844	22 April 2014	vessel	Iwate
254	OR	Lost Creek	44.551983	-124.073486	29 April 2014	tote	
*255	WA	Ocean Shores	46.972447	-124.176611	7 May 2014	tote	
257	HI	Oahu: between Sandy Beach an Erma’s	21.289992	-157.665069	6 October 2014	pontoon section	
*258	OR	Seal Rock: Quail Street	44.414208	-124.083808	23 February 2013	container box doors	
259	OR	Bay Ocean	45.520389	-123.95667	February 2013	carboy	
260	OR	Retz Creek, sout of Port Orford	42.712125	-124.461944	11 March 2013	wooden dock frame	
261	OR	Gold Beach: Kissing Rock	42.386447	-124.424722	1 April 2013	Post & Beam wood	
262	OR	Bandon	43.115111	-124.436436	1 April 2013	post-and-beam wood	
263	OR	Crooked Creek, Bandon (Devil’s Kitchen State Park)	43.0818833	-124.437222	1 April 2013	milled log	
*264	WA	Long Beach Peninsula: Oysterville	46.551036	-124.061892	22 December 2014	tree	

265	OR	Newport: Moolack Beach	44.699717	-124.0636	1 April 2014	post-and-beam wood	
266	OR	Newport: Moolack Beach	44.699717	-124.0636	1 April 2013	post-and-beam wood	
267	OR	Newport: Moolack Beach	44.699717	-124.0636	1 April 2013	post-and-beam wood	
269	OR	Newport: Moolack Beach	44.699717	-124.0636	1 April 2014	post-and-beam wood	
271	OR	Newport: Moolack Beach	44.699717	-124.0636	1 April 2014	post-and-beam wood	
272	OR	Newport: Moolack Beach	44.699717	-124.0636	1 April 2014	post-and-beam wood	
274	OR	Newport: South Beach	44.607683	-124.0687	1 April 2013	post-and-beam wood	
*277	OR	Seal Rock	44.414208	-124.083808	30 November 2014	tote	
280	OR	Lincoln City: Road's End	45.008075	-124.009661	1 April 2014	post-and-beam wood	
281	WA	Long Beach Peninsula: Oysterville	46.551036	-124.061892	8 May 2014	carboy	
*282	WA	Long Beach Peninsula: Oysterville	46.551036	-124.061892	8 May 2014	milled wood	
*283	WA	Long Beach Peninsula: Oysterville	46.551036	-124.061892	8 May 2014	buoy	
284	WA	Long Beach Peninsula	46.475511	-124.071969	23 December 2014	buoy	
285	WA	Long Beach Peninsula	46.475511	-124.071969	4 January 2015	vessel	
286	WA	Long Beach Peninsula	46.475511	-124.071969	January 2015	fillet board	
287	WA	Long Beach Peninsula	46.475511	-124.071969	January 2015	tote	
*288	OR	Beverly Beach	44.7199	-124.059308	20 January 2015	pallet	
289	OR	Tillamook South Jetty Beach (north of the Cape)	45.561572	-123.952322	18 January 2015	tote	
290	OR	Tillamook	45.561572	-123.952322	18 January 2015	tote	
291	OR	Tillamook South Jetty Beach (north of the Cape)	45.561572	-123.952322	18 January 2015	tote	
292	WA	Tokeland	46.704481	-123.974444	20 January	tote	

					2015		
*293	WA	Long Beach Peninsula	46.475511	-124.071969	28 January 2013	pipe	
295	WA	Long Beach Peninsula	46.475511	-124.071969	27 January 2015	sieve lid	
296	OR	Bandon: Bullard Beach	43.152231	-124.415278	1 April 2013	post-and-beam wood	
297	OR	Bandon: Bullard Beach	43.152231	-124.415278	1 April 2013	post-and-beam wood	
298	OR	Bandon: Bullard Beach	43.152231	-124.415278	1 April 2014	post-and-beam wood	
299	WA	Long Beach Peninsula	46.475511	-124.071969	11 February 2015	tote	
300	WA	La Push: Toleak Point	47.833653	-124.539722	10 February 2015	buoy	
301	WA	La Push: Strawberry Point	47.845478	-124.550000	11 February 2015	buoy	
302	WA	La Push: Strawberry Point	47.845478	-124.550000	11 February 2015	buoy	
303	WA	La Push: Strawberry Point	47.845478	-124.550000	11 February 2015	buoy	
*304	OR	in ocean off Newport	44.634933 (estimate)	-124.211486 (estimate)	12 February 2015	basket	
*305	OR	Lincoln City: Westwind Camp	45.038608	-124.006022	13 February 2015	crate	
*306	OR	Brookings	42.043511	-124.268592	10 February 2015	tote	
309	OR	Cape Arago: South Cove	43.303531	-124.396389	1 April 2013	post-and-beam wood	
311	HI	Oahu: Waimanalo Beach	21.328933	-157.689167	1 April 2013	post-and-beam wood	
312	HI	Oahu: Waimanalo Beach	21.328933	-157.689167	1 April 2013	post-and-beam wood	
313	HI	Kauai: Donkey Beach	22.115622	-159.296389	1 April 2014	post-and-beam wood	
315	HI	Kauai: Hanamaulu Beach	21.993161	-159.340833	9 November 2013	post-and-beam wood	
316	WA	Moclips	47.229131	-124.216706	1 April 2013	post-and-beam wood	

317	WA	Moclips	47.229131	-124.216706	1 April 2013	post-and-beam wood	
318	WA	Moclips	47.229131	-124.216706	2013-2014	post-and-beam wood	
321	WA	Grayland	46.805672	-124.105000	spring 2014	post-and-beam wood	
322	WA	Queets	47.540406	124.3568	October 2014	post-and-beam wood	
323	WA	Ocean Shores	46.972447	-124.176611	spring 2014	post-and-beam wood	
327	WA	Long Beach Peninsula: Oysterville	46.551036	-124.061892	spring 2013	milled log	
*328	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	tray	
*329	HI	Hawai‘i: Kohanaiki	19.694592	-156.044561	14 February 2015	vessel	Miyagi
*330	WA	Strawberry Point	47.845822	-124.550458	25 February 2015	buoy	
331	WA	Long Beach Peninsula: Oysterville	46.551036	-124.061892	14 March 2014	vessel	
332	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	lid	
333	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	pot	
334	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	urchin tray	
335	WA	Long Beach Peninsula	46.475511	-124.071969	March-April 2015	sieve	
336	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	buoy	
337	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	pipe	
*338	WA	Olympic Nationa Park	47.798108	-124.482242	22 May 2015	pallet	
*339	WA	Olympic Nationa Park	47.798108	-124.482242	16 May 2015	vessel	
340	BC	Wouwer Island: Beach	48.898867	-125.33145	29 March 2015	pallet	
*341	WA	Olympic Nationa Park	47.798108	-124.482242	22 May 2015	buoy	
342	WA	Olympic Nationa Park	47.798108	-124.482242	22 May 2015	buoy	
343	WA	Long Beach Peninsula	46.475511	-124.071969	March-April 2015	tote	
344	OR	Cape Perpetua	44.290814	-124.112208	7 April	tote	

					2015		
345	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014	frame	
346	WA [not HI]	Waikiki Beach	46.278106	-124.07865	1 April 2015	tote	
*347	OR	Seal Rock	44.414208	-124.083808	14 April 2015	buoy	
348	OR	Seal Rock	44.414208	-124.083808	14 April 2015	buoy	
*349	WA	Copalis Beach	47.116217	-124.184644	14 April 2015	tank	
350	WA	Moclips	47.229131	-124.216706	14 April 2015	sieve	
*352	WA	Long Beach Peninsula	46.475511	-124.071969	30 March 2015	vessel	
353	WA	Moclips	47.229131	-124.216706	5 April 2015	tote	
354	WA	Long Beach Peninsula	46.475511	-124.071969	3 April 2015	tote	
355	WA	Roosevelt Beach, Moclips	47.1722	-124.19536	6 April 2015	tote	
*356	OR	in ocean off Seal Rock	44.517033 (estimate)	-124.1203 (estimate)	9 April 2015	vessel	Iwate
357	WA	Ocean Shores	47.53138	-124.353	2012 to pre-April 2015	buoy	
*358	WA	Olympic National Park: Queets	47.540406	124.3568	9 April 2015	tray	
359	WA	Long Beach Peninsula	46.475511	-124.071969	13 April 2015	tote	
360	WA	Long Beach Peninsula	46.475511	-124.071969	25 April 2015	tote	
361	WA	Long Beach Peninsula	46.475511	-124.071969	25 April 2015	tote	
362	WA	Long Beach Peninsula: Oysterville	46.551036	-124.061892	29 July 2015	tote	
*363	WA	Long Beach Peninsula: Oysterville	46.551036	-124.061892	26 February 2015	bowl	
364	WA	Long Beach Peninsula: Oysterville	46.551036	-124.061892	8 May 2015	carboy	
365	WA	Ocean Shores	46.972447	-124.176611	5 July 2015	tote	
366	WA	Kayostia Beach	48.037831	-124.68265	15 July	boom	

					2015		
*367	WA	Long Beach Peninsula: Oysterville	46.551036	-124.061892	29 July 2015	tote	
368	WA	Long Beach Peninsula	46.475511	-124.071969	18 May 2015	lid	
*369	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	tote	
370	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	rebar cap	
371	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	eel trap	
372	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	tote	
373	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	tote	
374	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	tote	
375	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	top	
376	WA	Long Beach Peninsula: Seaview	46.475511	-124.071969	25 May 2015	tote	
377	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	pan	
378	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	tote	
379	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	tote	
380	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	tote	
*382	CA	San Francisco: Ocean Beach	37.759711	-122.511564	26 May 2015	tote	
383	WA	Long Beach Peninsula	46.475511	-124.071969	March-April 2015	tote	
384	WA	Long Beach Peninsula	46.475511	-124.071969	25 December 2014	tote	
*386	WA	Long Beach Peninsula	46.475511	-124.071969	March-April 2015	buoy	
*387	WA	Long Beach Peninsula	46.475511	-124.071969	25 December 2014	frame	
*388	WA	Long Beach Peninsula	46.475511	-124.071969	25 December 2014	tote	
389	WA	Long Beach Peninsula	46.475511	-124.071969	25 December 2014	tote	
390	WA	Long Beach	46.475511	-124.071969	January-	propeller	

		Peninsula			March 2015		
391	WA	Long Beach Peninsula	46.475511	-124.071969	January-March 2015	cylinder	
392	WA	Long Beach Peninsula	46.475511	-124.071969	March-April 2015	cutting board	
393	WA	Long Beach Peninsula	46.475511	-124.071969	March-April 2015	tub	
395	WA	Long Beach Peninsula	46.475511	-124.071969	March-April 2015	crate	
396	WA	Moclips	47.229131	-124.216706	14 April 2014	pallet	
397	WA	Long Beach Peninsula	46.475511	-124.071969	1 May 2015	pontoon section	
398	WA	Long Beach Peninsula	46.475511	-124.071969	March-April 2015	octopus trap	
400	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	mirror cover	
401	WA	Kalaloch Beach	47.605564	-124.378775	7 August 2015	buoy	
*402	WA	Seaview	46.475511	-124.071969	10 May 2015	vessel	
403	WA	Kalaloch	47.605564	-124.378775	25 April 2015	buoy	
404	OR	Kissing Rock Beach	42.386447	-124.424722	25 August 2015	buoy	
*405	WA	Long Beach Peninsula	46.475511	-124.071969	March-April 2015	tote	
*406	WA [not HI]	Waikiki Beach	46.278106	-124.07865	March-April 2015	tote	
407	WA	Long Beach Peninsula	46.475511	-124.071969	March-April 2015	bucket	
408	WA	Long Beach Peninsula	46.475511	-124.071969	March-April 2015	tote	
409	WA	Long Beach Peninsula	46.475511	-124.071969	March-April 2015	tote	
*410	OR	open ocean off Newport	44.576869	-124.695656	10 February 2015	tote	
411	OR	open ocean off Newport	44.576869	-124.695656	10 February 2015	tote	
412	WA	Long Beach Peninsula	46.475511	-124.071969	March-April 2015	tote	
413	WA	Long Beach Peninsula	46.475511	-124.071969	January-March 2015	tote	
*414	WA	Long Beach Peninsula	46.475511	-124.071969	14 December	tote	

					2014		
415	WA	Long Beach Peninsula	46.475511	-124.071969	January-February 2015	plastic fragment	
416	OR	Newport: South Beach	44.607683	-124.0687	spring 2013	milled log	
417	OR	open ocean off Newport	44.576869	-124.695656	25 February 2015	tote	
418	WA	Long Beach Peninsula	46.475511	-124.071969	26 May 2015	tote	
420	WA	Long Beach Peninsula: Oysterville	46.551036	-124.061892	26 May 2015	vessel panel	
421	HI	Kauai: Kealia Point	22.090506	-159.304722	1 April 2014	post-and-beam wood	
422	OR	Bandon	43.115111	-124.436436	15 December 2013	post-and-beam wood	
423	OR	Gold Beach: Barley Beach	42.456883	-124.423803	14 May 2015	pallet	
424	OR	Crook Point, south of Gold Beach	42.25125	-124.412772	28 March 2015	tote	
425	OR	Crook Point	42.25125	-124.412772	17 April 2015	golf caddy leg	
426	WA	Queets	47.540406	-124.3568	9 April 2015	tray	
427	OR	Cape Arago	43.307539	-124.399283	28 May 2015	plastic bar	
428	WA	Long Beach Peninsula: Oysterville	46.551036	-124.061892	11 April 2015	buoy	
429	WA	Queets	47.540406	-124.3568	9 April 2015	tray	
430	WA	Ocean Shores	47.53138	-124.353	2014	tray	
433	OR	Kissing Rock Beach, south of Gold Beach	42.386447	-124.424722	16 December 2014	bucket	
434	CA	Bodega Bay: Doran Spit	38.311311	-123.047500	1 April 2013	post-and-beam wood	
435	WA	Long Beach Peninsula (Surfside and north)	46.475511	-124.071969	4 November 2015	bin	
436	WA	Long Beach Peninsula: north of	46.551036	-124.061892	5 November 2015	tray	

		Oysterville Approach					
437	WA	Long Beach Peninsula: Oysterville	46.551036	-124.061892	5 November 2015	tote	
438	WA	Long Beach Peninsula	46.475511	-124.071969	8 May 2015	buoy	
439	WA	Long Beach Peninsula	46.475511	-124.071969	29 May 2015	buoy	
440	OR	Beverly Beach	44.7199	-124.059308	16 December 2015	buoy	
441	OR	Bandon: 3.2 km south of Coquille Poin	43.108092	-124.436389	week of 2 November 2015	tote	
442	WA	Long Beach Peninsula	46.475511	-124.071969	14 November 2015	buoy	
443	WA	Long Beach Peninsula	46.475511	-124.071969	9 December 2015	tote	
444	WA	Long Beach Peninsula	46.475511	-124.071969	2015	tote	
445	WA	Long Beach Peninsula	46.475511	-124.071969	15 December 2015	buoy	
446	WA	Long Beach Peninsula	46.475511	-124.071969	17 December 2015	tote	
447	WA	Long Beach Peninsula	46.475511	-124.071969	22 December 2015	tote	
448	WA	Long Beach Peninsula: Leadbetter Point	46.475511	-124.071969	22 December 2015	rope/tote	
*449	WA	Moclips	47.229131	-124.216706	29 May 2014	vessel	
451	OR	Nye Beach	44.642333	-124.063011	26 December 2015	buoy	
452	WA	Long Beach Peninsula	46.475511	-124.071969	24 December 2015	buoy	
453	HI	Oahu: Waimanalo	21.328933	-157.689167	1 April 2014	post-and-beam wood	
454	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	styrofoam-wood panel	
*455	WA	Copalis Beach	47.116217	-124.184644	3 April 2015	buoy	
456	OR	Bandon	43.115111	-124.436436	20	tote	

					December 2015		
457	OR	Manzanita	45.720494	-123.945572	28 February 2015	tote	
*458	WA	Long Beach Peninsula	46.475511	-124.071969	15 April 2015	fish box	
459	WA	Ocean Shores	46.972447	-124.176611	4 December 2015	buoy	
460	WA	Ocean Shores	46.972447	-124.176611	4 December 2015	plastic fragment	
461	OR	Manzanita	45.720494	-123.945572	28 February 2015	tote	
462	WA	Long Beach Peninsula	46.475511	-124.071969	4 January 2015	buoy	
463	WA	Queets	47.540406	-124.3568	9 April 2015	tray	
464	WA	Queets	47.540406	-124.3568	16 December 2015	tote	
465	WA	Queets	47.540406	-124.3568	16 December 2015	tote	
466	OR	Queets	47.540406	-124.3568	23 January 2015	tote	
467	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	tote	
468	WA	Long Beach Peninsula: 4.8 km north of Oysterville	46.551036	-124.061892	13 March 2014	pallet	
469	WA	Queets	47.540406	-124.3568	16 December 2015	tote	
470	WA	Queets	47.540406	-124.3568	16 December 2015	tote	
471	WA	Queets	47.540406	-124.3568	16 December 2015	line	
472	WA	Queets	47.540406	-124.3568	16 December 2015	tote	
473	WA	Queets	47.540406	-124.3568	16 December 2015	tote	
474	WA	Queets	47.540406	-124.3568	16	tote	

					December 2015		
475	WA	Queets	47.540406	-124.3568	16 December 2015	tote	
476	WA	Long Beach Peninsula: near Leadbetter Point	46.475511	-124.071969	25 December 2015	tote	
477	WA	La Push to Kalaloch	47.605564	-124.378775	10 May 2015	buoy	
478	WA	La Push to Kalaloch	47.605564	-124.378775	24 May 2015	buoy	
479	WA	La Push to Kalaloch	47.605564	-124.378775	24 May 2015	buoy	
480	WA	La Push to Kalaloch	47.605564	-124.378775	July 2015	buoy	
481	WA	Long Beach Peninsula	46.475511	-124.071969	23 December 2015	buoy	
482	WA	Roosevelt Beach Moclips	47.229131	-124.216706	2015	rope	
483	OR	Cape Lookout	45.36350	-123.97057	1 April 2014	post-and-beam	
485	WA	Long Beach Peninsula: Oysterville	46.63135	-124.07090	1 April 2013	post-and-beam	
486	WA	Long Beach Peninsula: Oysterville	46.63135	-124.07090	1 April 2013	post-and-beam	
487	WA	Long Beach Peninsula: Oysterville	46.63135	-124.07090	1 April 2013	post-and-beam	
488	WA	Long Beach Peninsula: Oysterville	46.63135	-124.07090	1 April 2013	post-and-beam	
489	WA	Long Beach Peninsula: Oysterville	46.63135	-124.07090	1 April 2013	post-and-beam	
493	WA	Long Beach Peninsula: Oysterville	46.63135	-124.07090	1 April 2014	vessel panel	
494	OR	Gold Beach: Pistol River	42.277378	-124.408819	1 April 2013	post-and-beam	
495	OR	Bandon	43.115111	-124.436436	22 May 2014	wood-metal fragment	
496	WA	Long Beach Peninsula	46.475511	-124.071969	29 January 2016	tote	
*497	HI	Oahu: Laie	21.648594	-157.921944	25 January 2016	vessel	Aomori

498	WA	Long Beach Peninsula	46.475511	-124.071969	11 February 2016	tote	
499	WA	Long Beach Peninsula	46.475511	-124.071969	15 February 2016	buoy	
500	WA	Long Beach Peninsula	46.475511	-124.071969	16 February 2016	tote	
501	WA	Long Beach Peninsula	46.475511	-124.071969	18 February 2016	tree	
502	WA	Long Beach Peninsula	46.475511	-124.071969	20 February 2016	buoy	
503	WA	Long Beach Peninsula	46.475511	-124.071969	20 February 2016	buoy	
504	CA	Bodega Bay: Salmon Creek Beach	38.324833	-123.0728	5 March 2016	plastic cap	
505	WA	Long Beach Peninsula	46.475511	-124.071969	7 March 2016	buoy	
506	WA	Long Beach Peninsula: Leadbetter Point	46.475511	-124.071969	7 March 2016	buoy	
507	OR	Tillamook Bay: Bay Ocean Peninsula	45.561572	-123.952322	7 March 2016	buoy	
508	OR	Arch Cape	45.816578	-123.964722	19 February 2016	tote	
509	WA	Long Beach Peninsula	46.475511	-124.071969	7 March 2016	buoy	
510	WA	Ocean Shores	47.53138	-124.353	2012-2015	buoy	
511	WA	Ocean Shores	47.53138	-124.353	2012-2015	buoy	
512	WA	Ocean Shores	46.972447	-124.176611	between 2012 and 2015	buoy	
513	OR	Gold Beach: Kissing Rock	42.362	-124.42448	21 December 2015	buoy	
514	OR	Tillamook	45.561572	-123.952322	16 January 2016	buoy	
515	OR	Bandon	43.115111	-124.436436	22 December 2015	buoy	
516	OR	Tillamook: Sout Jetty	45.561572	-123.952322	16 January 2016	plastic bar	
517	OR	Cape Blanco,	42.82883	-124.5506	28	tote	

		south near Eel River			December 2015		
518	WA	Long Beach Peninsula	46.475511	-124.071969	14 March 2016	buoy	
519	WA	Long Beach Peninsula	46.475511	-124.071969	7 March 2016	container	
520	OR	Tillamook Bay: Bay Ocean Peninsula	45.561572	-123.952322	14 March 2016	buoy	
*521	OR	Nye Beach	44.642333	-124.063011	14 March 2016	tote	
522	OR	Newport: South Beach	44.607683	-124.0687	16 March 2016	buoy	
523	OR	Gold Beach: Pistol River	42.277378	-124.408819	21 March 2016	shoe	
524	OR	Gold Beach: Myers Creek Beach	42.311950	-124.416389	3 March 2016	broom handle	
525	OR	Yachats	44.335344	-124.099811	16 March 2016	dust pan	
*526	OR	Horsfall Beach	43.454106	-124.277689	22 March 2016	vessel	
527	OR	Hubbard creek	42.735542	-124.478703	24 March 2016	pot	
528	OR	Hubbard creek	42.735542	-124.478703	24 March 2016	tray	
529	OR	Hubbard creek	42.735542	-124.478703	24 March 2016	buoy	
530	OR	Hubbard creek	42.735542	-124.478703	24 March 2016	vessel	
*531	OR	Seal Rock: Quai Street	44.483056	-124.084503	25 March 2016	buoy	
*532	WA	Kalaloch	47.6019	-124.375589	26 March 2016	vessel	Iwate
*533	OR	Lincoln City: Road's End	45.008075	-124.009661	27 March 2016	vessel	
534	OR	Long Beach Peninsula: 3.2km south of Leadbetter Point	46.475511	-124.071969	25 March 2016	tote	
535	WA	Long Beach Peninsula	46.475511	-124.071969	3 April 2016	rope	
536	WA	Long Beach Peninsula	46.475511	-124.071969	5 April 2016	tote	
537	OR	South of Winchester Bay	43.646717	-124.213056	15 April 2016	tote	
*538	OR	Sixes River	42.855417	-124.543953	16 April 2016	vessel	
539	HI	Kauai: Kealia	22.090506	-159.304722	1 April	milled log	

		Beach			2013		
540	HI	Kauai: Kealia Beach	22.090506	-159.304722	1 April 2013	milled log	
541	WA	Long Beach Peninsula	46.475511	-124.084503	15-17 April 2016	tote	
542	WA	Long Beach Peninsula	46.475511	-124.084503	12 April 2016 [re-drift]	post-and-beam wood	
543	OR	Seal Rock: Quai Street	44.483056	-124.084503	18 April 2016	buoy	
544	OR	Seal Rock Quail Street beach	44.483056	-124.084503	18 April 2016	dish rack	
545	OR	mouth of the Umpqua River	43.667692	-124.214722	26 March 2016	vessel	
546	OR	Moolack Beach Bridge	44.699717	-124.0636	29 April 2016	barrel fragment	
547	WA	Long Beach Peninsula	46.475511	-124.071969	14 May 2016	tote	
548	WA	Long Beach Peninsula	46.475511	-124.071969	16/17 May 2016	buoy	
549	WA	Long Beach Peninsula	46.475511	-124.071969	16 May 2016	tote	
550	WA	Long Beach Peninsula	46.475511	-124.071969	16 May 2016	buoy	
551	WA	Long Beach Peninsula	46.475511	-124.071969	September-December 2015	tote	
553	WA	Long Beach Peninsula	46.475511	-124.071969	31 December 2015	pot	
554	WA	Pacific Beach	47.208714	-124.210833	12 April 2015	plastic object	
*555	HI	Oahu: Alan Dav Beach	21.297578	-157.654742	22 April 2015	vessel	Miyagi
556	OR	Bandon: Mars Street	43.087114	-124.436469	14 January 2016	bucket lid	
557	OR	Gold Beach: Crook Point	42.25125	-124.412772	26 March 2016	tote	
558	OR	Gold Beach: Crook Point	42.25125	-124.412772	26 March 2016	tote	
559	OR	Gold Beach: Crook Point	42.25125	-124.412772	26 March 2016	buoy	
560	OR	Gold Beach: Crook Point	42.25125	-124.412772	26 March 2016	black bar	
561	OR	Bandon	43.115111	-124.436436	6 November 2015	tote	
562	OR	Gold Beach: Pistol River	42.277378	-124.408819	18 March 2016	buoy/rope	

563	WA	Long Beach Peninsula	46.475511	-124.071969	2 April 2015	tote	
564	WA	Long Beach Peninsula	46.475511	-124.071969	2 April 2015	lid	
565	WA	Long Beach Peninsula	46.475511	-124.071969	2 April 2015	tote	
566	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014-March 2015	lid	
567	WA	Long Beach Peninsula	46.475511	-124.071969	25 February 2015	buoy	
569	OR	Manzanita	45.720494	-123.945572	28 February 2015	bowl	
570	OR	Manzanita	45.720494	-123.945572	28 February 2015	tote	
571	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014-March 2015	tote	
572	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014-March 2015	bumper	
573	OR	in ocean off Heceta Head	44.1355 (estimate)	-124.220289 (estimate)	December 2014-March 2015	tote	
574	OR	in ocean off Heceta Head	44.1355 (estimate)	-124.220289 (estimate)	10 February 2015	tote	
575	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014-March 2015	tote	
576	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014-March 2015	jug	
577	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014-March 2015	tote	
578	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014-March 2015	tote	

579	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014- March 2015	float	
580	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014- March 2015	tote	
581	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014- March 2015	bowl	
582	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014- March 2015	lid	
583	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014- March 2015	plastic fragment	
585	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014- March 2015	cylinder	
586	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014- March 2015	shelving	
587	WA	Long Beach Peninsula	46.475511	-124.071969	December 2014- March 2015	tote	
588	WA	Long Beach Peninsula	46.475511	-124.071969	25 February 2015	lid	
589	OR	Moolack / Beverly Beach	44.715225	-124.060472	15 June 2016	buoy	
590	OR	Crook Point	42.25125	-124.412772	16 March 2016	buoy	
591	WA	Olympic Nationa Park: Mosquito Creek	47.798108	-124.482242	21 April 2015	tote	
592	OR	Bandon: Mars Street	43.087114	-124.436469	14 January 2016	tote	
593	WA	Long Beach Peninsula	46.475511	-124.071969	16 April 2016	tote	
594	WA	Long Beach Peninsula: Leadbetter	46.475511	-124.071969	1 February 2016	tote	
595	WA	Long Beach	46.475511	-124.071969	1 February	tote	

		Peninsula: Leadbetter			2016		
596	OR	Lane County: Bob Creek Wayside	44.262031	-124.110000	19 April 2015	tote	
597	WA	North Ocean Par	46.475511	-124.071969	24 January 2016	tote	
598	WA	Long Beach Peninsula	46.475511	-124.071969	16 February 2016	buoy	
599	WA	Long Beach Peninsula	46.475511	-124.071969	26 April 2015	tote	
600	OR	Crook Point South	42.25125	-124.412772	15 June 2016	bottle cap	
601	OR	Crook Point South	42.25125	-124.412772	15 June 2016	buoy	
602	OR	Crook Point South	42.25125	-124.412772	17 June 2016	tire	
603	WA	Beard's Hollow, south of Long Beach	46.305194	-124.075278	16 May 2015	tote	
604	WA	Long Beach Peninsula	46.475511	-124.071969	2016 May	tote	
605	WA	Long Beach Peninsula: Leadbetter Point	46.475511	-124.071969	2015	buoy	
606	WA	Long Beach Peninsula	46.475511	-124.071969	8 March 2015	buoy	
607	WA	Surfside	46.475511	-124.071969	17 May 2015	buoy	
608	WA	Long Beach Peninsula: near Ocean Park	46.475511	-124.071969	15 April 2015	tote	
609	WA	Long Beach Peninsula	46.475511	-124.071969	15 March 2016	buoy	
610	WA	Long Beach Peninsula: Leadbetter	46.475511	-124.071969	14 May 2015	tote	
611	WA	3 miles north of Long Beach	46.475511	-124.071969	13 May 2015	buoy	
612	WA	Long Beach Peninsula: Leadbetter	46.475511	-124.071969	16 March 2016	buoy	
613	WA	Long Beach Peninsula: Leadbetter	46.475511	-124.071969	19 February 2016	buoy	
614	OR	Lincoln Co.: Moolack Beach	44.699717	-124.0636	11 April 2016	tote	

615	WA	Long Beach Peninsula: 4.8km south of Leadbetter Point	46.475511	-124.071969	26 May 2015	buoy	
616	WA	Long Beach Peninsula	46.475511	-124.071969	May-September 2015	can	
617	WA	Quinault Indian Reservation: South Queets	47.400867	-124.330544	21 May 2015	fiberglass foam piece	
618	WA	Long Beach Peninsula	46.475511	-124.071969	12 January 2016	buoy	
619	WA	Long Beach Peninsula: Leadbetter Point	46.475511	-124.071969	24 December 2015	buoy	
621	WA	Long Beach Peninsula: Leadbetter Point	46.475511	-124.071969	22 December 2015	buoy/rope	
622	WA	Long Beach Peninsula: Leadbetter Point	46.475511	-124.071969	25 December 2015	tote	
623	WA	Long Beach Peninsula: Leadbetter Point	46.475511	-124.071969	24 December 2015	tote	
624	OR	0.5 miles north of Yaquina Head light, Newport	44.679414	-124.070833	20 December 2015	tote	
625	WA	Long Beach Peninsula	46.475511	-124.071969	2 June 2015	pallet	
626	HI	Kauai: Kapa‘a	22.081806	-159.312128	25 June 2016	vessel	Miyagi
627	HI	Kauai: Kapa‘a Beach	22.081806	-159.312128	1 April 2016 [re-drift]	post-and-beam wood	
628	OR	Newport: South Beach	44.607683	-124.0687	24 April 2013	post-and-beam wood	
629	OR	Newport: South Beach	44.607683	-124.0687	27 April 2013	post-and-beam wood	
630	OR	Newport: South Beach	44.607683	-124.0687	27 April 2013	post-and-beam wood	
631	WA	Grays Harbor County: Roosevelt	47.175278	-124.199167	12 August 2015	pallet	

		Beach					
632	OR	Seal Rock: Quail Street	44.483056	-124.083808	14 April 2015	tote	
633	HI	Kauai: Waipake Beach	22.207492	-159.338625	29 September 2013	post-and-beam wood	
634	OR	Newport: South Beach	44.607683	-124.0687	16 March 2016	buoy	
635	OR	Moolack Beach	44.699717	-124.0636	17 May 2016	buoy	
636	OR	Manzanita	45.720494	-123.945572	28 February 2015	tote	
637	OR	Moolack Beach	44.699717	-124.0636	8 April 2015	tote	
638	OR	Sacchi Beach	43.264578	-124.38645	23 April 2016	vessel	Miyagi
639	WA	Long Beach Peninsula	46.475511	-124.071969	February-May	buoy	
640	OR	Newport: Agate Beach	44.66455	-124.061158	23 March 2016	tote	
641	WA	Long Beach Peninsula	46.475511	-124.071969	5 July 2016	pallet	
642	WA	Long Beach Peninsula	46.475511	-124.071969	6 July 2016	tote	
643	WA	Long Beach Peninsula	46.475511	-124.071969	15 March 2016	buoy	
645	WA	Long Beach Peninsula	46.475511	-124.071969	January-May 2016	buoy	
646	OR	Manzanita	45.720494	-123.945572	28 February 2015	bucket	
647	WA	Long Beach Peninsula: Leadbetter Point	46.475511	-124.071969	15 March 2016	buoy	
648	OR	Crook Point South	42.25125	-124.412772	26 March 2016	lid	
649	OR	Moolack / Beverly Beach	44.715225	-124.060472	10 April 2016	jug	
650	WA	Long Beach Peninsula	46.475511	-124.071969	10 July 2016	table	
651	OR	Nye Beach	44.642333	-124.063011	13 July 2016	tree	
*652	OR	Falcon Cove	45.781247	-123.969906	20 July 2016	vessel	
653	HI	Oahu: Kahuku	21.683367	-157.944247	13 March 2016	buoy	
654	HI	Oahu: Kailua	21.405117	-157.738383	11 March 2016	buoy	

655	HI	Papahanaumokuake Marine National Monument, in ocean	25.752922 (estimate)	-170.458333 (estimate)	1 June 2015	fish bin	
656	OR	Otter Crest	44.756714	-124.064444	26 March 2016	jug	
657	WA	Long Beach Peninsula	46.475511	-124.071969	April-May 2015	buoy	
658	OR	Newport: South Beach	44.607683	-124.0687	5 October 2016	pallet	
659	WA	Long Beach Peninsula	46.475511	-124.071969	May 2015	tote	
660	WA	Long Beach Peninsula	46.475511	-124.071969	2014	tire	
661	HI	Hawai‘i: south of Honokohau Harbor, Kona	19.664656	-156.030736	17 November 2016	buoy	
662	HI	Hawai‘i: Kamilo Point	18.974297	-155.597222	19 November 2016	tote	
663	WA	Long Beach Peninsula	46.475511	-124.071969	8 November 2016	tote	
664	WA	Long Beach Peninsula	46.475511	-124.071969	30 November 2016	buoy	
665	WA	Long Beach Peninsula	46.475511	-124.071969	1 December 2016	buoy	
666	CA	Daly City: Mussel Rock Beach	37.672642	-122.495833	25 July 2015	tote	
*667	HI	Kauai: Kapa‘a	22.081806	-159.312128	7 December 2016	rope/buoys	
668	OR	Bandon	43.088001	-124.435364	15 March 2016	tube	
669	OR	Bandon	43.088001	-124.435364	15 March 2016	sieve	
670	OR	Bandon	43.088001	-124.435364	15 March 2016	pot	
671	OR	Bandon	43.088001	-124.435364	15 March 2016	tubing	
672	OR	Bandon	43.088001	-124.435364	18 April 2016	lid	
673	WA	Long Beach Peninsula	46.475511	-124.071969	27 May-15 September 2015	tote	

674	WA	Long Beach Peninsula	46.475511	-124.071969	27 May-15 September 2015	plastic piece	
675	HI	Oahu: Waimanalo	21.328933	-157.689167	22 December 2016	vessel	Miyagi
676	OR	Bandon	43.088001	-124.435364	15 December 2016	tote	
677	HI	Hawai‘i: southeast coast on DHHL lands	18.911128	-155.678056	16 January 2017	vessel	
678	WA	Long Beach Peninsula	46.475511	-124.071969	12 February 2017	buoy	
*679	WA	Long Beach Peninsula	46.475511	-124.071969	16 February 2017	buoy	

Table S2.
List of species recorded on Japanese Tsunami Marine Debris.
A. Japanese species
* Asterisked species were reproductive upon arrival (with gametes, gametic tissue, or brooded young) or were present in 2 or more age classes (generations).

CHROMISTA
Rhizaria
Foraminifera
Cibicides lobatulus
Elphidium crispum
Bolivina cf. *B. seminuda*
Acervulina inhaerens
**Cornuspira involvens*
Dyocibicides perforata
**Miliolinella subrotunda*
Nonionella stella
Planogypsina squamiformis
Planorbulina mediterranensis
**Rosalina globularis*
Trochammina sp.
Homotrema rubra
Cercozoa
Gromia "oviformis"
Ciliophora
Suctoria
Species A (yellow)
Species B (white)
Folliculinidae
Unidentified sp.
Vorticellidae
Vorticella sp.
Zoothamniidae
Zoothamnium sp.
PORIFERA
**Callyspongia* sp.
Chalinidae, unidentified sp.
**Clathrina* sp.
Cliona sp.
**Halichondria panicea*
**Hymenciadon sinapium*
**Leucandra* sp.
**Leucosolenia eleanor*
**Mycale macginitei*
**Sycon raphanus*
**Ute* sp.
CNIDARIA
Hydrozoa
Thecata
Abietinaria inconstans

Aglaophenia aff. *A. pluma*
**Amphisbetia furcata*
Antenella sp.
**Campanularia volubilis*
**Clytia hemisphaerica*
Clytia linearis
Clytia cf. C. universitatis
Eutima japonica
Halecium tenellum
Halecium delicatulum
**Halopteris* aff. *campanula*
Hydrodendron gracile
Hydrodendron mirabile
**Laomedea flexuosa*
**Obelia longissima*
Obelia dichotoma
**Obelia geniculata*
Orthopyxis caliculata
Orthopyxis platycarpa
Phialella quadrata
**Plumalecium plumularioides*
**Plumularia setacea*
Plumularia caliculata
Sertularella sp. A
Sertularella mutsuensis
Symplectoscyphus tricuspidatus

Athecata

Stylacteria sp.
Bougainvillia muscus?
Unidentified anthoathecate sp. A

Anthozoa

Actiniaria

Metridium dianthus
**Anthopleura* sp.
**Diadumene lineata*
Diadumene cf. *D. franciscana*
?Urticina sp.
Actiniaria sp. A
Actiniaria sp. B
Actiniaria sp. C

Scleractinia

Pocillopora damicornis

NEMATODA

Unidentified spp. (3+)

NEMERTEA

Lineidae, unidentified sp.
Quasitetrastemma nigrifrons
Oerstedia dorsalis
Unidentified sp.

PLATYHELMINTHES

Rhabditophora

Tricladida

Uteriporidae?

Unidentified spp. (2+)

Monogenea

Benedenia seriolae?

Heteraxine heterocerca?

SIPUNCULA

Phascolosoma scolops

ANNELIDA

Oligochaeta

Unidentified spp. (2+)

Polychaeta

Capitellidae

Unidentified sp.

Nereididae

Nereis pelagica

Perinereis nigropunctata

Phyllodocid

Eulalia quadrioculata

Eulalia viridis-complex

Eteone sp.

Nereiphylla cf. *N. castanea*

Polynoidae

Halosydna brevisetosa-complex

Harmothoe imbricata

Lepidonotus sp.

Syllidae

Syllis elongata-complex

Syllis hyalina-complex

Syllis cf. *S. ehlersoides*

Syllis cf. *S. farallonensis*

Syllis cf. *S. pulchra*

Syllis gracilis-complex

Syllinae spp. 1-6

Sphaerosyllis sp.

Trypanosyllis zebra?

Amblosyllis speciosa-complex (D)

Terebellidae

Amphitrite sp.

Terebella sp.

Oenonidae

Arabella semimaculata-group

Onuphidae

Unidentified sp.

Spionidae

Polydora sp.

Pygospio californica

Orbiniidae

Naineris sp.

Chrysopetalidae
Unidentified sp.
Paleanotus sp.
Acrocirridae
Acrocirrus sp.
Fabriciidae
Unidentified sp.
Sabellariidae?
Unidentified sp.
Sabellidae
Amphiglena sp.
Serpulidae
Hydroides ezoensis
Serpula sp.
Spirobranchus cf. *S. minutus*
Spirobranchus sp.
Salmacina sp.?
Spirorbidae
Unidentified spp.

MOLLUSCA

Gastropoda

Lottiidae
Lottia dorsuosa
Lottia versicolor
Lottia tenuisculpta
Lottia kogamogai
Lottia sp.
Lottia sp. N-D Eernisse
Lottia sp. O
Lottia sp. BF3
Nipponacmea habei
Nacellidae
Cellana grata
Calyptraeidae
Crepidula onyx
Vermetidae
Serpulorbis sp.
Columbellidae
Mitrella moleculina
Mitrella sp. A
Muricidae
Reishia bronni
Pulmonata
Siphonariidae
Siphonaria sirius
Siphonaria sp.
Nudibranchia
Dolabella auricularia
Hermissenda crassicornis
Dendronotus frondosus
Eubranchus sp.

Dorididae, unidentified sp.
Unidentified sp.

Bivalvia

Mytilidae
**Mytilus galloprovincialis*
Mytilus coruscus
Mytilus trossulus
Modiolus kurilensis
Modiolus nipponicus
Modiolarca cuprea
Trichomusculus semigranatus
Mytilisepta virgata
Septifer bilocularis
Lithophaga lischkei

Anomiidae
Monia umbonata
Monia macrochisma

Gryphaeidae
Hyotissa quercinus
Neopycnodonte cochlear

Ostreidae
Crassostrea gigas
Crassostrea bilineata
Crassostrea circumpicta
Dendostrea folium

Spondylidae
Spondylus cruentus

Arcidae
Arca boucardi
Hawaiarca uwaensis
Barbatia lima
Barbatia virescens

Pectinidae
Glorichlamys quadrilirata
Laevichlamys squamosa
Laevichlamys cuneata
Pascahinnites coruscans
Patinopecten yessoensis
Semipallium barnetti

Limidae
Limaria hirasei

Pteriidae
Pteria sp.
Pinctada albina
Pinctada margaritifera
Isognomon legumen

Malleidae
Malleus irregularis

Chamidae
Chama argentata
Chama cerinorhodon

Chama dunkeri
Chama japonica
Myidae
Sphenia coreanica
Hiatellidae
Hiatella orientalis
Teredinidae
**Psiloteredo* sp.
**Teredothyra smithi*
Bankia carinata
Bankia bipennata
Lyrodus takanoshimensis
Teredo navalis

Polyplacophora

Mopalia seta
Acanthochitona achates
Acanthochitona sp. A
Acanthochitona rubrolineata
Placiphorella stimpsoni

ARTHROPODA: Crustacea

Copepoda

Harpacticus sp.- *flexus* group
**Harpacticus compsonyx*
**Harpacticus septentrionalis*
**Harpacticus nicaceensis*
**Harpacticus* sp.
**Parastenhelia spinosa*
**Tisbe* spp.
**Paralaophonte congenera*
**Sarsamphiascus minutus*
**Sarsamphiascus varians* group
**Heterolaophonte discophora*
Heterolaphonte sp.
**Paramphiascella fulvofasciata*
Ambunguipes aff. *rufocincta*
**Dactylopodamphiascopsis latifolius*

Ostracoda

Sclerochilus verecundus
Sclerochilus sp. 1
Sclerochilus sp. 2
**Xestoleberis setouchiensis*
Obesotoma cf. *O. setosum*
Obesotoma sp.
Paradoxostomatidae

Cirripedia

Megabalanus rosa
Megabalanus zebra
Megabalanus sp.
**Semibalanus cariosus*
Balanus crenatus
Balanus glandula

Balanus trigonus
Chthamalus challengeri
Pseudoctomeris sulcata
Tetraclita japonica

Amphipoda

Ischyroceridae
**Jassa marmorata*-complex

Ampithoidae
Ampithoe valida
Ampithoe lacertosa
Ampithoe koreana

Stenothoidae
Stenothoe crenulata-complex

Photidae
*Gammaropsis japonic*a

Dogielinotidae
Allorchestes sp.

Pleustidae
Trachypleustes sp.

Caprellidae
**Caprella mutica*
**Caprella cristibrachium*
Caprella penantis
Caprella equilibra
Caprella drepanochir

Tanaidacea
**Zeuxo normani*

Isopoda
**Ianiropsis serricaudis*
Ianiropsis derjugini
Munna japonica
Dynoides spinipodus

Decapoda
Hemigrapsus sanguineus
Oedignathus inermis
Sphaerozius nitidus

PYCNOGONIDA
Endeis nodosa

INSECTA

Diptera
**Telmatogeton japonicus*

ACARINA

Halacaridae
Halacarellus schefferi

BRYOZOA

Cheilostomata
Aetea anguina
Callaetea sp.
Biflustra grandicella
Biflustra irregulata
Biflustra cf. *B. arborescens*

Arbocuspis sp.
**Bugula* sp.
Bugulina stolonifera
Callopora craticula
Catenicella sp.
Cauloramphus spinifer
Cauloramphus sp. A
Celleporaria brunnea
**Celleporella hyalina*
Celleporina porosissima
Celleporina cf. *C. globosa*
Celleporina sp. A
Celleporina sp. B
Conopeum nakanosum
Cribrilina mutabilis
Cryptosula pallasiana
Drepanophora cf. *D. gutta*
**Escharella hozawai*
**Exochella tricuspis*
**Fenestrulina* cf. *F. orientalis*
Membranipora villosa
**Metroperiella* cf. *M. biformis*
Microporella borealis
Microporella luellae
Microporella neocriboides
Rhynchozoon sp.
Schizoporella japonica
**Scruparia ambigua*
Smittoidea spinigera
**Tricellaria inopinata*
Watersipora mawatarii
Watersipora cf. *W. typica*

Cyclostomata

**Crisia* sp. A
Crisia cf. *C. serrulata*
Crisidia sp.
Disporella cf. *D. novaehollandiae*
?*Entalophora* sp.
Filicrisia cf. *F. franciscana*
Proboscina sp.
Stomatopora sp.
Tubulipora misakiensis
Tubulipora pulchra

Ctenostomata

Alcyonidium sp.
Walkeria prorepens

KAMPTOZOA

Barentsia sp.

ECHINODERMATA

Asteroidea

Asterias amurensis

Aphelasterias japonica
Patiria pectinifera

Echinoidea

Temnotrema sculptum

Holothuroidea

Havelockia versicolor

Ophiuroidea

Unidentified sp.

CHORDATA

Ascidiacea

Botrylloides sp.
Botryllus sp.
Didemnum perlucidum
Didemnum vexillum
Herdmania cf. *H. pallida*
Perophora sp.

PISCES

Oplegnathus fasciatus
Seriola aureovittata

B. Oceanic Pelagic (Neustonic) Species

CNIDARIA

Hydrozoa

Obelia griffini

ANNELIDA

Polychaeta

Amphinome rostrata

ARTHROPODA: Crustacea

Amphipoda

Caprella andreae

Cirripedia

Lepas spp.
Conchoderma auritum

Decapoda

Planes major
Plagusia immaculata
Plagusia squamosa

MOLLUSCA

Gastropoda

Fiona pinnata

Bivalvia

Teredora princesae
Uperotus clava

BRYOZOA

Cheilostomata

Jellyella tuberculata
Jellyella eburnea
Arbopercula angulata

C. North East Pacific Nearshore Species Acquisitions

ANNELIDA

Polychaeta

Polynoidae

ARTHROPODA: Crustacea

Cirripedia

Balanus glandula
Balanus crenatus
Pollicipes polymerus

Isopoda

Gnorimosphaeroma sp.
Idotea wosnesenskii
Idotea resecata

Amphipoda

Atylus tridens
Ptilohyale littoralis
Parhyale sp.

MOLLUSCA

Bivalvia

Mytilus spp.
Crassadoma gigantea
Hiatella arctica
Kellia suborbicularis

BRYOZOA

Cheilostomata

Pomocellaria californica

CHORDATA

Ascidiacea

Styela gibbsii
Pyura haustor

Table S3.

Frequency of Occurrence of Eight Most Common Living JTMD Species.

Phylum	**Class / Order**	**Species**	**Number of JTMD-BF items on which species was found alive (of 511 items with living biota)**	**Frequency of living individuals on JTMD-BF items**
Mollusca	Bivalvia	*Mytilus galloprovincialis*	261	51.1%
Bryozoa	Cheilostomata	*Scruparia ambigua*	203	39.7%
Bryozoa	Cheilostomata	Aeteidae *(Aetea anguina, Callaete*a sp.)	69	13.5%
Arthropoda	Amphipoda	*Jassa marmorata*	45	8.8%
Arthropoda	Isopoda	*Ianiropsis serricaudis*	39	7.6%
Bryozoa	Cheilostomata	*Bugula* sp.	35	6.8%
Arthropoda	Cirripedia	*Megabalanus rosa*	35	6.8%

Table S4.
Rarefaction Richness Estimators.
Total Species Pool Estimates (Fig. S9)

Species	Chao	Chao.se	jack1	jack1.se	jack2	boot	boot.se	n	Object Type
207	357.1794	40.87116	309.0636	33.90454	376.1425	250.4914	20.12108	110	all

Vessels Only Species Pool Estimates (Fig. S10)

Species	Chao	Chao.se	jack1	jack1.se	jack2	boot	boot.se	n	Object Type
120	262.4554	45.39058	199.4348	25.68605	250.5343	158.3187	14.04685	46	vessels

Buoys Only Species Pool Estimates (Fig. S10)

Species	Chao	Chao.se	jack1	jack1.se	jack2	boot	boot.se	n	Object Type
56	170.3537	57.08107	95.04762	15.33895	126.1262	71.68656	7.285661	21	buoy

Other Objects Species Pool Estimates (Fig. S10)

Species	Chao	Chao.se	jack1	jack1.se	jack2	boot	boot.se	n	Object Type
57	85.99408	14.62032	83.92308	7.778365	98.24923	69.0067	4.468681	26	other

Table S5. Systematic zoologists and other scientists contributing to the identification of invertebrates, protists, and fish on Japanese Tsunami Marine Debris.

Scientist	Affiliation	Taxon
Bjørn Altermark	Arctic University of Norway, Tromsø, Norway	Teredinidae
Claudia Arango	Queensland Museum, Australia	Pycnogonida
David Bilderback	Bandon, Oregon, USA	Bryozoa
Philip E. Bock	Mount Waverley, Victoria, Australia	Bryozoa
Luisa M. S. Borges	Helmholtz-Zentrum Geesthacht, Germany	Teredinidae
Ralph Breitenstein	Oregon State University, Hatfield Marine Science Center, USA	General invertebrates
Stephen Cairns	Smithsonian Institution, National Museum of Natural History, USA	Scleractinia
Dale Calder	Royal Ontario Museum, Canada	Hydrozoa
James T. Carlton	Williams College, Massachusetts USA and Williams-Mystic Maritime Studies Program, Connecticut, USA	General invertebrates; Mollusca; Cirripedia
Benny Chan	Academia Sinica, Taiwan, China	Cirripedia
John W. Chapman	Oregon State University, Hatfield Marine Science Center, USA	Amphipoda, Isopoda, Tanaidacea, Decapoda; general invertebrates
Henry Choong	Royal British Columbia Museum, Canada	Hydrozoa
Eugene V. Coan	Santa Barbara Museum of Natural History, California, USA	Bivalvia
Jeffery R. Cordell	University of Washington, USA	Copepoda
Matthew T. Craig	NOAA, National Marine Fisheries Service, La Jolla, California, USA	Pisces
Natalia Demchenko	Zhirmunsky Institute, Vladivostok, Russia	Amphipoda
Matthew Dick	Hokkaido University, Japan	Bryozoa
Anthony Draeger	Kensington, California, USA	Polyplacophora
Douglas J. Eernisse	California State University, Fullerton, USA	Gastropoda; Polyplacophora
David Elvin	Oregon Marine Porifera Project, Shelburne, Vermont, USA	Porifera
Neal Evenhuis	B. P. Bishop Museum, Hawaiʻi, USA	Chironomidae
Daphne Fautin	University of Kansas, USA	Anthozoa
Karin H. Fehlauer-Ale	Universidade Federal do Paraná, Brazil	Bryozoa
Kenneth Finger	University of California, Berkeley, USA	Foraminifera
Megan Flenniken	Stony Brook University, New York, USA	Anthozoa
Toshio Furota	Toho University, Japan	General invertebrates
Aaron Gann	Oregon State University, USA	Pisces
Jonathan Geller	Moss Landing Marine Laboratories, USA	General invertebrates

Jeffrey H. R. Goddard	University of California, Santa Cruz, USA	Nudibranchia
Scott Godwin	NOAA Honolulu, USA	General invertebrates
Dennis P. Gordon	National Institute of Water & Atmospheric Research, Wellington, New Zealand	Bryozoa
Terry Gosliner	California Academy of Sciences, San Francisco, USA	Nudibranchia
Takuma Haga	National Museum of Nature and Science, Tokyo, Japan	Bivalvia
Niels-Viggo Hobbs	University of Rhode Island, USA	Isopoda
Leslie Harris	Los Angeles County Museum of Natural History, USA	Polychaeta
John Holleman	Merritt College, Oakland, California, USA	Platyhelminthes
Gyo Itani	Kochi University, Japan	Decapoda
Collin Johnson	Harvard University, USA	Bryozoa
Hiroshi Kajihara	Hokkaido University, Japan	Nemertea
Gerald Krantz	Oregon State University, USA	Halacaridae
Elena Kupriyanova	Australian Museum, Australia	Serpulidae
Gretchen Lambert	University of Washington, USA	Ascidiacea
Robert N. Lea	California Academy of Sciences, San Francisco, California, USA (formerly California Department of Fish and Wildlife)	Pisces
Katrina Lohan	Smithsonian Environmental Research Center, Edgewater, Maryland, USA	Haplosporida
Konstantin Lutaenko	Zhirmunsky Institute, Vladivostok, Russia	Mytilidae
Joshua Mackie	California State University, San Jose, USA	Bryozoa
Christopher Mah	Smithsonian Institution, National Museum of Natural History, USA	Asteroidea
Svetlana Maslakova	University of Oregon Institute of Marine Biology, USA	Nemertea
Linda McCann	Smithsonian Environmental Research Center, Edgewater, Maryland, USA	Bryozoa
Megan I. McCuller	Williams College, Massachusetts USA and Williams-Mystic Maritime Studies Program, Connecticut, USA	Bryozoa
Mary McGann	U.S. Geological Survey, Menlo Park, California, USA	Foraminifera
Gary McDonald	University of California, Santa Cruz, USA	Nudibranchia
James H. McLean	Los Angeles County Museum of Natural History, USA	Gastropoda
Richard Mooi	California Academy of Sciences, San Francisco, California, USA	Echinoidea

Bruce Mundy	National Marine Fisheries Service, Hawai‘i, USA	Pisces
Katherine Newcomer	Smithsonian Environmental Research Center, Edgewater, Maryland, USA	Anthozoa
Eijiroh Nishi	Yokohama National University, Japan	Annelida
Teruaki Nishikawa	Nagoya University, Japan	Sipuncula
Atsushi Nishimoto	National Research Institute of Fisheries Sciences, Japan	Teredinidae
Jerrold G. Norton	Pacific Grove, California, USA (formerly National Marine Fisheries Service)	Pisces
Ronald Noseworthy	Jeju National University, South Korea	Polyplacophora
Peter Ng	National University of Singapore, Singapore	Decapoda
Michio Otani	Osaka Museum of Natural History, Japan	Cirripedia; General Invertebrates
David Pawson	Smithsonian Institution, National Museum of Natural History, USA	Holothuroidea
Erik Pilgrim	National Exposure Research Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio, USA	Gastropoda, Polyplacophora
Michael J. Raupach	Carl von Ossietzky University, Oldenburg, Germany	Teredinidae
Gregory Ruiz	Smithsonian Environmental Research Center, Edgewater, Maryland, USA	Haplosporida, Hydrozoa
Hiroshi Saito	National Museum of Nature and Science, Japan	Polyplacophora
Eric Sanford	University of California, Davis, Bodega Marine Laboratory, California USA	Anthozoa
J. Reuben Shipway	Northeastern University, Nahant, Massachusetts USA	Teredinidae
Ashleigh Smythe	Virginia Military Institute, USA	Nematoda
Jackie Sones	University of California, Davis, Bodega Marine Laboratory, California USA	Anthozoa
Ichiro Takeuchi	Ehime University, Japan	Amphipoda
Hayato Tanaka	Hiroshima University, USA	Ostracoda
Paul D. Taylor	Natural History Museum, London, England	Bryozoa
Nancy Treneman	University of Oregon Institute of Marine Biology, USA	Teredinidae
Paul Valentich-Scott	Santa Barbara Museum of Natural History, California, USA	Bivalvia
Leandro Manzoni Vieira	Universidade Federal de Pernambuco, Brazil	Bryozoa
Judith Winston	Smithsonian Marine Station, Fort Pierce, Florida, USA	Bryozoa

Moriaki Yasuhara	University of Hong Kong, China	Ostracoda

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5. See Supplementary Text in the supplementary materials.
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