

**North Pacific Marine Science Organization (PICES)**  
**PICES-MoE project on “Effects of marine debris caused by the Great Tsunami of 2011”**  
**Year 2 Final Report**

**1. PROJECT INFORMATION**

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<b>Title:</b>	Development of life history database for Japanese Tsunami Marine Debris (JTMD) biota
<b>Award period</b>	15 May 2015 to 31 March 2016
<b>Amount of funding</b>	\$14,620 US direct funds (\$1,370 indirect)
<b>Report submission date</b>	April 30, 2016
<b>Lead Author of Report*</b>	Jessica Miller

\*Although there may be only one lead author of the report, all PIs and co-PIs of the project, as identified in the approved statement of work and listed below, are responsible for the content of the Final Report in terms of completeness and accuracy.

**Principal Investigator(s), Co-Principal Investigators and Recipient Organization(s):**

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**2. EXECUTIVE SUMMARY**

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**Describe both the research purpose, objectives, methods, results, achievements and challenges, timelines and milestones (2-3 pages)**

The overall goal of the PICES project, Assessing the Debris Related Impact From Tsunami (ADRIFT), funded by Ministry of the Environment of Japan, is to assess and forecast the effects of debris generated by the tsunami that followed the 2011 Great East Japan Earthquake. The assessment is focused on the coastlines and communities along the west coast of North America and Hawaii. Prior grants from Oregon Sea Grant, the US National Science Foundation, and the North Pacific Marine Science Organization (PICES) resulted in substantial progress on documenting the biota arriving on JTMD and evaluating the growth and condition of some

commonly occurring species. To date, over 500 JTMD items with >250 invertebrate taxa have been documented arriving along the west coast of the US and Canada and in Hawaii and other NW Pacific Islands.

The establishment of and impacts from the biota transported on JTMD may not be known for years to decades after their arrival and could, hopefully, be small to non-existent. While we do not know if any of these species will establish in the NE Pacific, it is important to build upon our current knowledge base. A logical and important step in addition to understanding the arrival phase is to compile existing information on these JTMD species for a variety of purposes, including formal risk assessment, life history and ecological analyses, and comparison with other marine invasive species and vectors. Such information is not only an opportunity to learn more about the dispersal and transport of marine species but also critical for a robust risk assessment and addressing key ecological questions about the JTMD species pool.

The approach to address this information need was to collaborate with PICES researcher (Clarke Murray) and staff to develop a database on JTMD species attributes, including information on geographic distribution, temperature and salinity ranges, invasion history, reproductive mode, etc. In spring 2015, we designed and distributed a template to other researchers who provided input on its design. With the assistance of Jocelyn Nelson (PICES contractor), the database, which includes descriptive and categorical fields, was finalized. Literature acquisition, interpretation, and data entry continued throughout the grant year. Due to the time required to populate the database, additional staff were hired by PICES in late 2015 and early 2016. After coordinating with Clarke Murray, Miller distributed a position description to identify a likely candidate to assist with database entry. Ms. Reva Gillman, a MS student at Oregon State University, was hired by PICES to assist with data entry and focused on Molluscan taxa. Information on many of the JTMD taxa that were identified to genus or species, as well as some higher order taxonomic groupings, have been compiled. There are some additional taxa to be added during spring 2016. Once finalized, the database will be housed by the Smithsonian Environmental Research Center as part of its National Exotic Marine and Estuarine Species Information System (NEMESIS), which will provide a comprehensive and valuable source of information on JTMD species to a variety of potential users.

### **3. PROGRESS SUMMARY**

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#### **a. Describe original proposed research and planned outputs**

**The proposed research approach and products as presented in the original proposal are below.**

A preliminary list of species and key attributes to be included in the literature review will be compiled and sent out for review by investigators working on JTMD biota (Carlton, Ruiz, Chapman, Geller, Otani, and others) for review and finalization of information to be included in review process. The compilation will include several life history traits, distributional characteristics, and prior invasion histories for JTMD and other NW Pacific coastal fouling species in order to inform risk assessments, address key hypotheses in invasion ecology and

assist with the education and management needs associated with JTMD biota. A variety of search tools in addition to exploration of known literature will be used to compile appropriate literature for inclusion. Efforts will be made to access and archive digital versions of all literature included.

There is a need to better understand attributes of JTMD species in order to evaluate their invasion potential and make comparisons with other better-known transport vectors. Examples of hypothesis that can be addressed once a comprehensive database is compiled included: 1) JTMD species prioritize reproduction over growth when compared with non-JTMD NW Pacific coastal fouling species. This hypothesis will be supported if JTMD species have shorter lifespans and higher early reproductive effort than NW Pacific coastal fouling species that did not arrive on JTMD. Alternatively, this hypothesis will be rejected if JTMD species display relatively long lifespans and delayed reproduction compared with non-JTMD species, which is a possible effect of the relatively long transoceanic residence associated with JTMD as a transport vector. 2) JTMD species can tolerate greater environmental variation, i.e., temperature, salinity, depth, and have larger geographic distributions, i.e., latitudinal distribution, than non-JTMD species. And 3) JTMD species overlap with NW Pacific species commonly found on other documented marine dispersal vectors, including ballast water and ship hull fouling. We will determine if JTMD species possess unique attributes compared with those species commonly found on these other documented transport vectors.

## **Products**

- A database of key distributional and life history metrics (see table below) in tabular form. A bibliography with related digital collection of primary sources, whenever possible, of all literature examined. This effort will result an extensive bibliography, a digital library, and a data matrix of species and their associated traits and distributions.
- The final disposition for the data matrix and associated digital library will be determined during Year 2. One potential option is to house the information, or components of the database on SERC's Nemesis webpage.

### **b. Describe progress.**

The database template, including information on geographic distribution, temperature and salinity ranges, invasion history, reproductive mode, etc., was developed in spring of 2015. After consultation with other researchers and the assistance of Jocelyn Nelson, a PICES contractor, the database structure, which includes descriptive and categorical fields, was finalized. The database includes 74 fields, included 28 categorical and 46 descriptive fields. Literature acquisition, interpretation, and data entry continued throughout the grant year. Due to the time required to populate the database, additional staff in both North America and Japan were hired in late 2015 and early 2016 to assist. After coordinating with Clarke Murray in late fall of 2015, Miller distributed a position description and identified three potential candidates to assist with database research. The most qualified candidate was Ms. Reva Gillman, a MS student at Oregon State University, who was hired to assist with data entry. Her efforts were focused on the phylum Mollusca, and she completed entry for 33 taxa and compiled digital copies of the literature

referenced in the database. Janson Wong was also hired to assist with database development. Overall, the database is an impressive and detailed compilation of key metrics for a substantial number of JTMD taxa that were identified to species or genus.

**c. Describe results.**

For this scope of work, the database template and its content were the primary, initial product. The database is detailed and constitutes a tremendous resource, including some information found only in Japanese literature. The original proposal outlined several key ecological questions that would be addressed once the database was completed or near completion. Given the rate of database development, those analyses are proposed to occur in Year 3. Additionally, early on in the development of the database, it was decided that including non-JTMD species would be overly time consuming so the scope of the database is limited to JTMD species. The work proposed for Year 3 included *expansion of the database* to include other known invasive species from the NW Pacific that arrived via other vectors, principally ballast water and hull fouling, as a proposed product. It is worth clarifying that the *proposed expansion* was focused on a *substantially reduced set of variables* that would be appropriate to include in a life history synthesis. In other words, the intent for the proposed expansion was to include only the existing database fields that are, or can be converted to, categorical or quantitative data. This reduced variable set (likely <30 of the 74 fields) is the proposed database expansion, more accurately referred to as an “addendum” to the existing database. Additionally, the intent of this “addendum” was not to represent a comprehensive synthesis of all known ballast water or hull fouling invasive species but rather a select, well-documented subset to provide a contrast to the JTMD species, which represent a unique collection of species. If such an addendum were developed, it would only occur *after* completing a life history synthesis of the JTMD species pool.

**d. Describe any concerns you may have about your project’s progress.**

The time to complete literature search, evaluation, and data entry varied extensively across taxa and took longer than anticipated. However, the database is also quite detailed and will be of use in both the risk analysis and other ecological analyses. As the plan is for the database to be housed by the Smithsonian Environmental Research Center as part of its National Exotic Marine and Estuarine Species Information System (NEMESIS), it will be accessible through the internet to interested parties, thus providing a comprehensive, unique, and valuable source of information on JTMD species.

The ecological analyses proposed, as noted above, could not occur at the end of Year 2 given the delayed database development. However, the analysis to quantify variability in attributes along statistically independent gradients and to compare traits of JTMD species with known invasion histories to remaining JTMD species could be initiated within a month when a “beta” version of the database will likely be available. As noted above, these analyses would be completed with a subset of the information in the database. The analysis would focus on categorical variables and thus incorporate a subset of the information in the database. It is likely that the subset would

include 25-30 fields, including information on geographic range, salinity and temperature requirements, invasion history, reproductive mode, and habitat characteristics.

#### **e. Completed and planned publications**

Miller, J. A., Carlton, J. T., Chapman, J. W., Geller, J. B., and Ruiz, G. The mussel *Mytilus galloprovincialis* on Japanese tsunami marine debris: A potential model species to characterize a novel transport vector. PICES Press 24(1): 24-28.

A manuscript based on the above analysis is in preparation. Target submission is July 2016.

#### **f. Poster and oral presentations at scientific conferences or seminars**

2016. Miller, J.A., Carlton, J.T., Chapman, J.W., Geller, J.B., Ruiz, G. The mussel *Mytilus galloprovincialis* on Japanese Tsunami Marine Debris: a potential model species to characterize a novel transport vector. 9<sup>th</sup> International Conference on Marine Bioinvasions, Sydney, Australia. [Poster presented by Carlton as Miller could not attend meeting]

2016. Carlton, J.T., Chapman, J.W., Geller, J.B., Miller, J.A., Ruiz, G., Carlton, D., and McCuller, M. The invasion process model and the transoceanic dispersal of coastal marine organisms by Japanese tsunami marine debris. 9<sup>th</sup> International Conference on Marine Bioinvasions, Sydney, Australia. [Oral presentation by Carlton]

2016. Geller, J.B., Campell, T., Carlton, J., Chapman, J. W., Heller, P., Miller, J. A., and Ruiz, G. DNA barcode and metagenetic approaches for monitoring and surveillance of marine invasive species in North American waters, with focus on 2011 Japanese Tsunami Marine Debris-associated species. 9<sup>th</sup> International Conference on Marine Bioinvasions, Sydney, Australia. [Oral presentation by Geller]

2016. Ruiz, G. M., Geller, J.B., Carlton, J., Chapman, J. W., Miller, J. A., DiMaria, R., Lohan, K., and Barnard, R. Japanese Tsunami Marine Debris: Potential Transoceanic Rafting of Bivalve Parasites and Pathogens. 9<sup>th</sup> International Conference on Marine Bioinvasions, Sydney, Australia. [Oral presentation by Ruiz]

#### **g. Education and outreach**

Miller was invited to participate in the Oregon Marine Debris Action Plan Workshop, held on April 13 and 14, 2016 in Newport, OR. Due to other commitments, Miller could not attend but Gillman participated. Gillman also brought outreach materials from Miller's lab, including a poster of frequently occurring JTMD non-native species and some preserved specimens of those species, to share at the workshop. The workshop brought together Oregon entities working on marine debris to develop an Oregon Marine Debris Action Plan. The Plan, when completed, will include current and desired marine debris work, gaps in marine debris efforts, and specific actions for addressing marine debris in the future. We raised the issue of potential transport of non-native species on marine debris in pre-workshop surveys and during the workshop.

Miller assisted with the development of a field guide produced by Oregon Sea Grant, *Key Aquatic Invasive Species Watch: Japanese Tsunami Marine Debris in the Eastern Pacific*, which received two awards including the Silver Award of Distinction from the 2016 Communicator Award and the 2016 Hermes Creative Awards Gold Award in the “Publications-Field Guide” category. Developers include Jennifer Lam and Sam Chan (OSU/Oregon Sea Grant); Gayle Hansen, John Chapman, and Jessica Miller (OSU); Jim Carlton (Williams College); Rick Boatner (ODFW); Rick Cooper, Pat Knight, Tania Siemens, and Kayla Martin (Oregon Sea Grant); Jared Corcoran (designer). A PDF of the guide was sent to PICES along with this report.

#### **4. PROGRESS STATUS**

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Overall, substantial progress was made although at a slower rate than originally envisioned. Any analysis of the database cannot, at this point, occur until Year 3. However, even moving ahead with the current database, there is more than enough information for a robust and informative analysis.