

The impact of Japanese tsunami debris on North America

by Cathryn Clarke Murray, Alexander Bychkov, Thomas Therriault, Hideaki Maki and Nancy Wallace

Introduction to the project

The Great Tōhoku Earthquake, or Great East Japan Earthquake, with magnitude 9.0, struck off the coast of Japan on March 11, 2011, and triggered a massive tsunami. This event was a natural disaster of staggering proportions, causing loss of human life, property destruction and environmental damage. One example of environmental cost was that of about 5 million tons of debris swept from the land and coastal systems into the ocean (Ministry of the Environment, Japan, 2014). The Government of Japan estimates that 70% of that debris sank close to shore, leaving 1.5 million tons floating in the North Pacific with the potential to arrive on North American coastlines (Bagulayan 2012; Lebreton and Borrero 2013).



Fig. 1 Marine debris accumulation in Kanapou Bay, Kaho'olawe, Hawaii (photo credit: NOAA).

The first confirmed instances of Japanese tsunami debris washing up on the shores of North America occurred in March 2012. Since then, over 1400 debris sightings have been reported, of which 50 pieces could be confirmed as Japanese-origin tsunami debris. This includes two large concrete docks, originally from Misawa, Japan, that were found on beaches in Oregon and Washington (with a number of non-native species attached). In addition, more than 150 small boats have washed ashore, many of which have been confirmed as lost during the tsunami. The North American coast already endures marine debris from terrestrial and aquatic sources (Keller *et al.* 2010; Ribic *et al.* 2012), but there may be additional impacts from the increase in abundance and differing debris types due to the tsunami (Fig. 1).

Aside from the impacts of additional marine debris, there is the possibility of debris carrying coastal Japanese organisms to North American coasts. The two docks together, mentioned above, had hundreds of Japanese

species and tens of thousands of individuals attached, alive, and some reproductively active. Many of the species were not known previously from North America and have the potential to invade coastal ecosystems (Gewin 2013). For example, five species of hydroid collected from tsunami debris were confirmed as non-native to the northwest United States (Calder *et al.* 2014).

PICES, with Working Group 21 on *Non-indigenous Aquatic Species* completed in 2012 and Working Group 31 on *Emerging Topics in Marine Pollution* formed in 2013, is well-placed to contribute to research on the potential impacts of Japanese Tsunami marine debris. As a result of generous funding from the Government of Japan through its Ministry of the Environment (MoE), PICES has initiated a new project to investigate the impact of tsunami-generated marine debris on North American coastal ecosystems. This 3-year effort (April 2014–March 2017) is directed by a Project Science Team (PST) made up of researchers from Canada, Japan, the United States and the PICES Secretariat, and is co-chaired by Thomas Therriault (Department of Fisheries and Oceans, Canada), Hideaki Maki (National Institute for Environmental Studies, Japan) and Nancy Wallace (NOAA Marine Debris Program, USA).

An initial PST meeting was held from July 30–August 1, 2014, at NOAA's Sand Point facility in Seattle, USA, and a meeting of the Project Co-Chairmen took place on October 17, 2014, in conjunction with the PICES Annual Meeting in Yeosu, Korea (Fig. 2). The next Project Co-Chairmen's meeting is planned for February 2015, in Sidney, Canada (the seat of the PICES Secretariat), followed by a PST meeting in March 2015 in Honolulu, combined with a visit to local debris beaches.

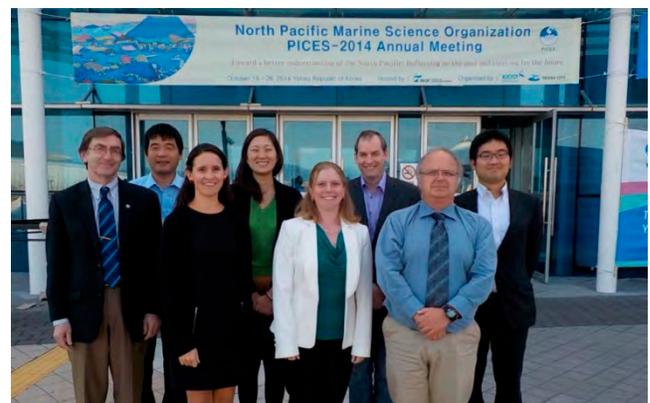


Fig. 2 Participants of the Project Co-Chairmen meeting, October 17, 2014, Yeosu, Korea (from left to right): Alexander Bychkov (PICES Secretariat), Hideaki Maki (Japan), Cathryn Clarke Murray (PICES/MoE Visiting Scientist), Karin Baba (Japan), Nancy Wallace (USA), Thomas Therriault (Canada), Robin Brown (Canada) and Kosuke Ishimaru (MoE, Japan).

The project will focus on three main areas of research:

- (1) Surveillance and monitoring of tsunami-generated marine debris landfall;
- (2) Modeling movement of marine debris in the North Pacific; and
- (3) Risk (including potential impacts) from invasive species to coastal ecosystems.

In this article, we briefly introduce one of our activities under the surveillance and monitoring component of the project – aerial surveys. Other project components will be described in upcoming issues of PICES Press.

Aerial surveys

As part of the surveillance and monitoring research, data gaps were identified for the northeast Pacific coast. While beaches in Washington State, Oregon and California are regularly visited, cleaned and monitored, little surveillance and monitoring occurs on the remote western-facing beaches of British Columbia and Alaska at risk of tsunami-debris landfall (based on model predictions). Aerial surveys are cost-effective ways to monitor these vast, largely uninhabited coastlines where debris may be accumulating, and to identify potential “hot spots”. Detecting large pieces

of debris and sampling them for any potential invasive species attached is a priority.

In October 2014, aerial surveys of British Columbia coastlines began, and to date over 650 kilometers have been captured, from Cape Scott south to Port Renfrew on the west coast of Vancouver Island (Fig. 3). The British



Fig. 3 Southern British Columbia aerial survey flight path (green line).



Fig. 4 Aerial photo surveys of western Vancouver Island, British Columbia, Canada: Japanese skiffs indicated by circles with dotted yellow lines on remote beaches (top photos); pristine beach (bottom left) and rocky beach (bottom right).

Columbia survey complements aerial surveys by the State of Alaska completed in 2013 and 2014 as part of their debris response and removal activities (State of Alaska 2014), and uses the same survey methodology (Airborne Technologies, Inc. 2009). These surveys consist of overlapping oblique photographs taken from a small plane flying between 500 and 1000 m from the beach (Fig. 4). Post-survey processing assigns unique identifiers (tags) for specific types of debris and quantifies the amount of debris on a qualitative scale from 0–5. When combined with ongoing beach monitoring data from NOAA (Opfer *et al.* 2012; Lippiatt *et al.* 2013) and disaster debris sightings (NOAA MDP 2013), debris accumulation hot spots will be identified and prioritized for future surveillance and research.

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Dr. Alexander Bychkov (bychkov@pices.int) was the Deputy Executive Secretary of PICES from 1996–1999 and the Executive Secretary of the Organization from 1999–2014. He serves now as a Special Projects Coordinator with PICES, and the project on “Effects of marine debris caused by the Great Tsunami of 2011”, funded by the Ministry of the Environment of Japan, is one of his primary responsibilities.

Dr. Thomas Therriault (thomas.therriault@dfo-mpo.gc.ca) is a Research Scientist with Fisheries and Oceans Canada working on a variety of invasive species issues. He is the Canadian Co-Chair of the project on “Effects of marine debris caused by the Great Tsunami of 2011”, funded by the Ministry of the Environment of Japan, and Chairman of PICES Science Board.

Dr. Hideaki Maki (hidemaki@nies.go.jp) is a Senior Researcher at the National Institute for Environmental Studies (NIES), Japan. He has studied microbial degradation of crude oil in marine environments and conducted some field experiments of crude oil bioremediation. Recently, he has been monitoring water and sediment parameters relevant to hypoxia in Tokyo Bay. After the Great East Japan Earthquake, he has been involved in monitoring hydrocarbons contamination of sediments in the Tohoku coastal sea. Hideaki is the Japanese Co-Chair of the project on “Effects of marine debris caused by the Great Tsunami of 2011”, funded by the Ministry of the Environment of Japan, and serves as a member of the PICES Marine Environmental Quality Committee and Working Group on Emerging Topics in Marine Pollution.

Nancy Wallace (nancy.wallace@noaa.gov) is the Director of the National Oceanic and Atmospheric Administration’s Marine Debris Program, which is the federal lead for researching, preventing, and reducing the impacts of marine debris in the United States. She is the US Co-Chair of the project on “Effects of marine debris caused by the Great Tsunami of 2011”, funded by the Ministry of the Environment of Japan, and serves as a members of the PICES Working Group on Emerging Topics in Marine Pollution. Nancy has worked on ocean policy related issues for the past decade. Her work includes resource conservation with the National Park Service, developing sustainable catch limits for fisheries off the east coast of the United States and efforts to improve water quality in the Gulf of Mexico.