

2011 PICES Rapid Assessment Survey

by Vasily Radashevsky, John Chapman, Leslie Harris and Thomas Therriault

The central question to be answered by the PICES Working Group 21 (WG 21), since its formation in 2006, has been whether increasing invasions of non-indigenous species (NIS) threaten marine resources of North Pacific countries. In accordance with its mission to increase understanding of marine NIS in the PICES area, WG 21 began work in 2007 on the NIS component of a 5-year project on “*Development of the prevention systems for harmful organisms’ expansion in the Pacific Rim*” supported by a voluntary contribution from the Ministry of Agriculture, Forestry and Fisheries of Japan, through the Fisheries Agency of Japan. This NIS component was further divided into two initiatives. Dr. Henry Lee II (U.S. Environmental Protection Agency; lee.henry@epa.gov) leads the first initiative, to develop a comprehensive database for non-indigenous North Pacific species. The second initiative, to conduct rapid assessment surveys (RAS) of PICES member countries, is being coordinated by Dr. Thomas Therriault (Fisheries and Oceans Canada; thomas.therriault@dfp-mpo.gc.ca). Both of these integrated initiatives have revealed: (1) significant and increasing threats to marine resources by NIS and (2) the critical importance of expanded international cooperation to resolve and manage them.

Responses to invasions are unlikely to be initiated or to be effective without understanding the problems they cause or collaborative efforts to manage them. Rapid assessment surveys are able to provide baseline data critical for measuring and limiting the rates and expansions of invasions among PICES member countries and are also indispensable for international calibration and standardization of both

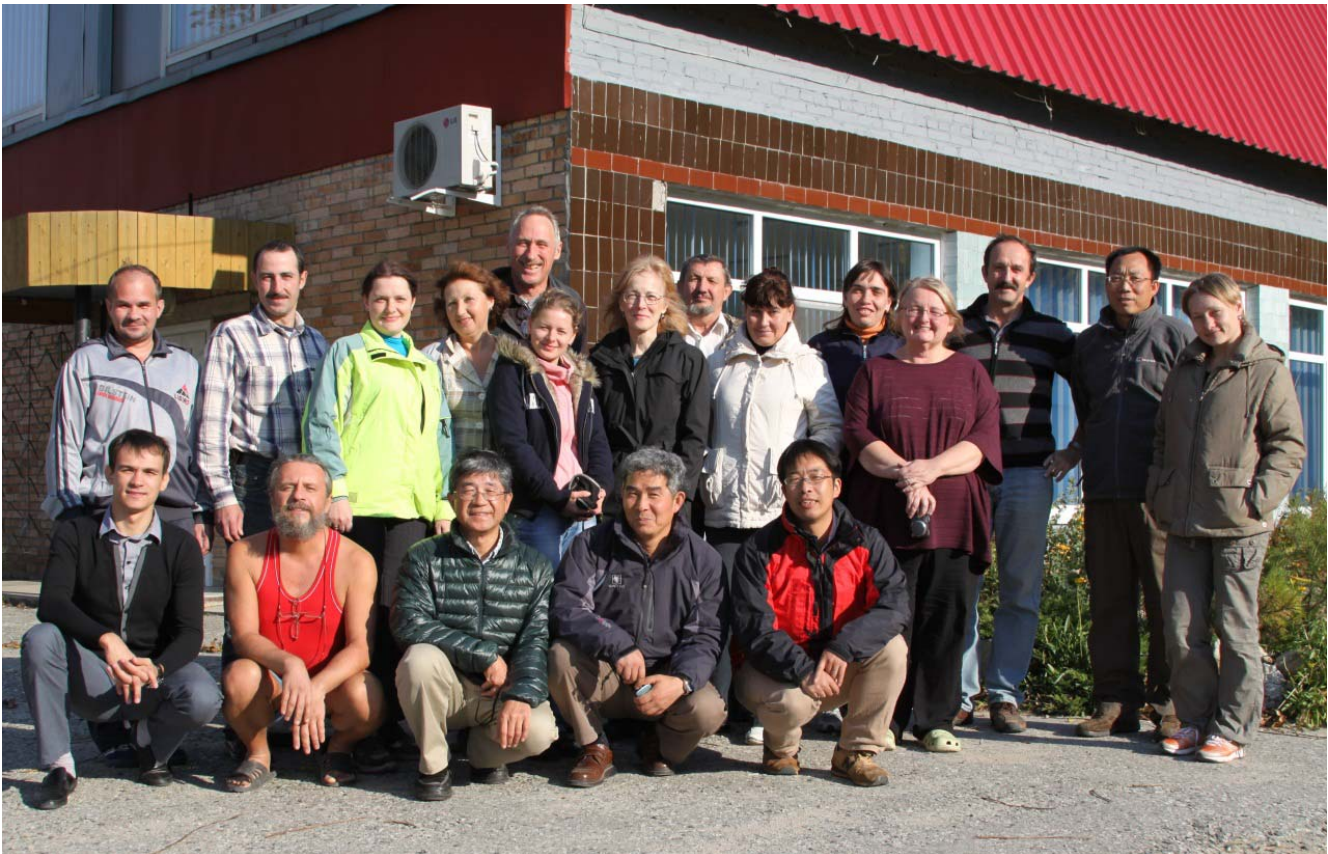
taxonomy and NIS detection. International ballast water traffic has been an especially important mechanism for transporting organisms into countries where high levels of secondary traffic (small craft and aquaculture) transfer these organisms to adjacent areas. The PICES surveys have been particularly useful for detecting and measuring invasions by all mechanisms.

The first PICES RAS was organized in Dalian, China, in 2008 (see PICES Press 17(1): 30–32). The second survey was conducted on Jeju Island, Korea, in 2009 (PICES Press 18(1): 38–40). The third one took place near Newport in central Oregon, U.S.A., in 2010 (PICES Press 19(1): 27–29). The 2011 survey described in this article was organized just prior to the 2011 PICES Annual Meeting in Khabarovsk, Russia.

The 2011 RAS was conducted in Peter the Great Bay, near Vladivostok and Nakhodka, the largest Far Eastern Region seaports of Russia. The survey was based at the *Vostok* Marine Biological Station of the A.V. Zhirmunsky Institute of Marine Biology (IMB) of the Far Eastern Branch of the Russian Academy of Sciences, which is located about 2 hours away in Vladivostok (see photo below). The *Vostok* Station, on the coast of Vostok Bay (an eastern extension of Peter the Great Bay), was established by the IMB in a comparatively clean area with diverse surrounding habitats to serve as an international base for marine studies. The biodiversity in the area has since become relatively well described due to continuous studies by scientists from all over the world.



Peter the Great Bay region, including Vladivostok, on the Muravyov-Amursky Peninsula and Vostok Bay to the east.



Participants in the 2011 PICES Rapid Assessment Survey of non-indigenous, cryptogenic and native species at the Vostok Marine Biological Station of the A.V. Zhirmunsky Institute of Marine Biology (taken by Leslie Harris). Front row (from left): Alexey Gorodkov, Alexander Rzhavsky, Hisashi Yokoyama, Jin-Woo Choi, Takeaki Hanyuda; back row: Evgeny Barabanshchikov, Iliia Korneichuk, Marina Nekrasova, Vera Radashevskaya, John Chapman, Oksana Belous, Gayle Hansen, Ivan Kashin Liudmila Budnikova, Natalia Demchenko Darlene Smith, Vasily Radashevsky, Xinzheng Li and Inna Alalykina (not in picture: Olga Golovan, Anastasia Mayorova and Leslie Harris).

As the previous year's RAS in Newport was particularly successful for polychaetes, small crustaceans, and marine algae, it was decided to focus on these groups again in 2011. A 7-member group, Leslie Harris (NHMLAC, U.S.A.), Vasily Radashevsky, Inna Alalykina and Marina Nekrasova (IMB), Alexander Rzhavsky (Severtsov Institute of Ecology and Evolution, RAS, Russia), Jin-Woo Choi (South Sea Research Institute, KORDI, Korea), and Hisashi Yokoyama (National Research Institute of Aquaculture, Japan), dealt with polychaetes. Another 7-member group, Liudmila Budnikova and, Evgeny Barabanshchikov and Iliia Korneichuk (TINRO-Center, Russia), John Chapman (Oregon State University, U.S.A.), Natalia Demchenko and Olga Golovan (IMB), and Xinzheng Li (Institute of Oceanology, CAS, China), surveyed crustaceans. Three participants, Oksana Belous (PIBOC, Russia), Gayle Hansen (Oregon State University, U.S.A.) and Takeaki Hanyuda (Kobe University Research Center for Inland Seas, Japan), worked with algae. Anastasia Mayorova (IMB) sampled for Sipunculida, and Evgeny Barabanshchikov did double duty, also surveying plankton. Alexey Gorodkov and Ivan Kashin (IMB) set the collector plates, and Darlene Smith (Fisheries and Oceans Canada) served as data manager. The entire survey was coordinated by Vasily Radashevsky.

The official survey took place from October 7–14. Several participants (Alalykina, Chapman, Demchenko, Hansen, Harris, Radashevsky and Rzhavsky) stayed on for another two weeks to maximize sampling efforts around the *Vostok* Station and to examine collections in Vladivostok. A seminar, with 10 reports on NIS research in the North Pacific, was organized at the station on October 13. Two additional lectures on introduced species issues were also delivered by Harris and Chapman at the Institute of Marine Biology in Vladivostok.

Most of the sampling was conducted in and around Vostok Bay in habitats that varied from small harbors to rocky points (see photo on next page) and mud flats. Collector plates (man-made attachment sites for species that prefer hard substrates) were deployed for about 5 months. Two sets of these plates were recovered from Vostok Bay harbors and one from the international harbor in Vladivostok.

The value of the PICES surveys depends on whether biological invasions affect marine ecosystems or human welfare, and whether managing or preventing these invasions can be cost effective. The surveys therefore focused on three relevant questions:



Participants of the PICES Rapid Assessment Survey on the rocky shore of Anna Bight, Anna Lighthouse Resort Point, near Vostok Bay, October 9, 2011.

- (1) What are the patterns, magnitudes and processes of biological invasions?
- (2) Can these invasions reduce food security, economic development or alter the ecological dynamics of natural ecosystems?
- (3) Can biological invasions be managed or prevented?

All PICES member countries appear to be addressing *Question 3* but are hindered by the absence of quantitative measures or rigorous theory for measuring effects or designing and testing responses. International efforts depend on close collaborations such as those that the PICES surveys have produced. The accumulating discoveries of the PICES surveys have addressed *Questions 1* and *2* in particular, and thus *Question 3* as well. A sampling of PICES discoveries follows.

The most fundamental parameters of invasion ecology, the origins of species (native, *N* or introduced, *I*) and their relative abundances ($R = I/N$) have proven elusive to measure in nearly all marine systems due to the large proportions of “cryptogenic species” (*C*), that cannot be confidently classified as *I* or *N*. The unmeasured dependence of *I* and *N* on *C* has prevented confident measures of *R*. Correlations between cryptogenic species with introductions but not with native species among sites and phyla were discovered in the PICES surveys. The majority of cryptogenic species are likely to be introduced and therefore, can be included among introduced species

for estimates of *R*. Preliminary analyses of other surveys around the world indicate a nearly universal association of cryptogenic species with introductions.

Another fundamental question has been whether the recently found invasions are due predominantly to rapidly increasing new mechanisms or to long-standing gradual increases only recently discovered. Comparisons of the dates of species descriptions with their dates of discovery in Peter the Great Bay revealed that most introduced species of the region were known more than 100 years before they were discovered in the bay. The majority of native macroscopic invertebrates, algae and plants recovered in recent surveys of Peter the Great Bay were also previously known. These discoveries of introduced species were therefore, not likely to have been overlooked among previously unreported species. More probable, these invasions are due to recent arrivals rather than to increases in research.

The PICES surveys permit analyses of climate effects on the rates and patterns of invasions. Nearly all of the introduced species discovered in Peter the Great Bay since 2009 were previously known from southern East Asian countries (Zvyagintsev *et al.* 2009, 2011). The restricted ranges and summer occurrences for most of these species are consistent with expanding southern populations or northern migration (Zvyagintsev *et al.* 2009, 2011). The recent invasions of Russia found in the PICES survey appear also to be northern shifts or expanding ranges of warm water species. The introduced and cryptogenic species found in the relatively pristine Vostok Bay area also indicate that they are not restricted to harbors and thus have broad distributions on the Russian coast, with significant potential to interact with valuable native populations.

Relative to whether marine invasions can threaten human welfare: none of the human-borne introduced species found in the October 2011 and earlier surveys (Zvyagintsev *et al.* 2009, 2011) are of economic value to Russia. Since all of these species have the potential to displace or replace economically valuable native species, the common introduced species to Russia thus appear more likely to be harmful than useful and also unlikely to make positive contributions to the native biota.

Population extinctions and displacement of native species coincident with introduced biological invasions are occurring in North America (Chapman *et al.*, in press), as species equilibrium models have predicted. Although invasions of the Russian coasts seem to be less intense than in North America, their rapid increases appear likely to soon bring them to North American intensities. The PICES surveys provide critical information and a mechanism to foster the international cooperation needed for each member country to detect and manage introduced species. International collaborations through PICES are thus

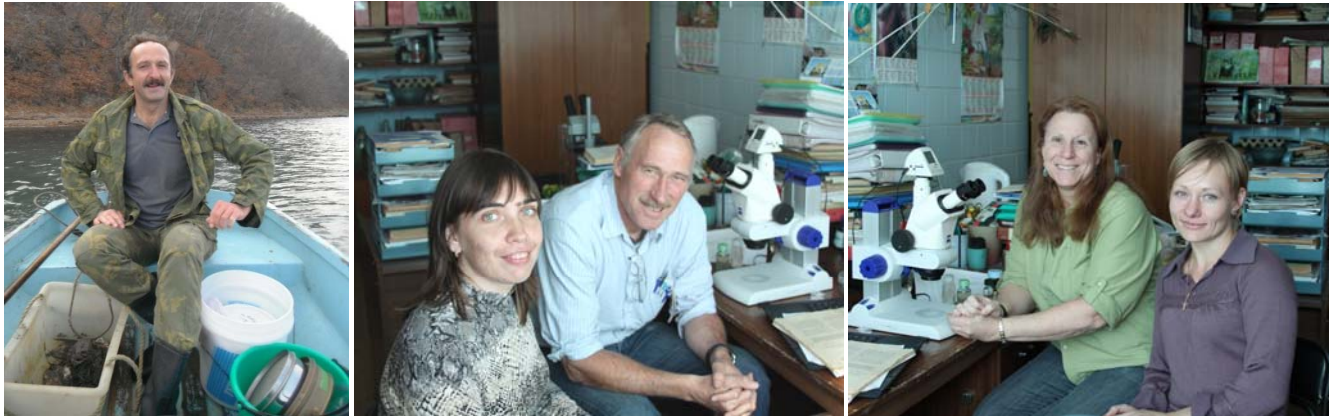
increasing the quality and resolution of taxonomic research on Asian coasts, increasing the resolution of invasion patterns and opening communications needed to permit relevant, cooperative responses to begin.

References

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Dr. Vasily Radashevsky (radashevsky@gmail.com; left photo) is a Research Scientist at the A.V. Zhirmunsky Institute of Marine Biology (IMB) of the Far Eastern Branch of the Russian Academy of Sciences in Vladivostok, Russia. Vasily studies the morphology, ecology, reproductive biology and phylogeny of marine worms of the family Spionidae (Annelida) which easily survive in ballast waters and are transported worldwide. He co-chairs PICES Working Group 21 on Non-indigenous Aquatic Species.

Dr. John Chapman (John.Chapman@oregonstate.edu; center photo, with Natalia Demchenko [amphipod taxonomist and ecologist at IMB]) is the Head of the Marine Biological Invasions Laboratory at the Hatfield Marine Science Center, in Newport, Oregon, U.S.A. In addition to the PICES rapid assessment surveys in 2009, 2010 and 2011, his research includes shallow water amphipod crustacean systematics and the parasite-host ecology of introduced and native bopyrid isopods and their host shrimps. John also teaches lower and upper division Aquatic Biological Invasions through the Departments of Biology and Fisheries and Wildlife at Oregon State University.

Leslie Harris (exogone@hotmail.com; left in right photo, reviewing North Pacific polychaete taxonomy with Inna Alalykina [polychaete taxonomist and ecologist at IMB]) is the Polychaete Collection Manager at the Natural History Museum of Los Angeles County, U.S.A. She has over 30 years of experience in identifying polychaetes from the Arctic to the Antarctic and points in between, with particular emphasis on the North Pacific fauna. A veteran of non-indigenous species surveys since 1998, Leslie was also a participant in the 2010 PICES rapid assessment survey. Her research focuses on taxonomic issues, distribution patterns, and resolution of introduction status of marine organisms, in general, and polychaete worms, in particular.

Dr. Thomas Therriault (Tom's photo can be seen in the next article; Thomas.Therriault@dfo-mpo.gc.ca) is a Research Scientist with Fisheries and Oceans Canada (DFO) at the Pacific Biological Station in Nanaimo, British Columbia. Tom is working on a number of aquatic invasive species research questions both within DFO and through the second Canadian Aquatic Invasive Species Network (CAISN II). He is the Principal Investigator for the Taxonomy Initiative of PICES Working Group 21 on Non-indigenous Aquatic Species (under the project on "Development of the prevention systems for harmful organisms' expansion in the Pacific Rim" supported by the Ministry of Agriculture, Forestry and Fisheries of Japan) that includes rapid assessment surveys for non-indigenous species. Within PICES, Tom serves as Vice-Chairman of Science Board and Chairman of the FUTURE Advisory Panel on Anthropogenic Influences on Coastal Ecosystems. He is a member of the Marine Environmental Quality Committee and the PICES/ICES Study Group on Developing a Framework for Scientific Cooperation in the Northern Hemisphere Marine Science.