【Grant-in-Aid for Scientific Research (S)】

Broad Section G

Title of Project： **Regime shifts in coastal marine ecosystems: an empirical approach based on advanced monitoring and nonlinear dynamical theory**

KONDOH, Michio
(Tohoku University, Graduate School of Science, Professor)

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【Purpose and Background of the Research】

Anthropogenic disturbances and global changes may cause a dramatic shift in species composition and degradation of ecosystem services. Such an abrupt change in ecosystems is called “regime shift”, which is, according to theory, caused by a change in dynamical property of ecosystems. However, there are few direct empirical evidences from real nature. How to forecast a regime shift is another question that has not been fully answered.

There are two major difficulties to overcome to advance the empirical study of regime shift. First, we are lacking of good monitoring data of regime shift happening in nature. Ecological monitoring is usually effort-demanding and therefore it is not straight forward to capture a regime shift of many-species communities in the field. Second, we are lacking of effective methods that enable evaluating the dynamical property of ecological systems. Consequently, the link between regime shift and dynamical properties is left unanswered.

In the present project we are to give a better empirical understanding of, and to develop a method to forecast, ecological regime shifts by combining the advanced ecological monitoring method and data analytical tools, which allow us overcoming the two abovementioned difficulties.

【Research Methods】

Environmental DNA, the recently monitoring method for biodiversity, forms the basis of present project. The eDNA technique allows one to make a list of biological species from the DNA fragments organisms shed into the environmental water (Fig. 1). We conduct weekly to monthly eDNA monitoring at dozens of monitoring sites located along Japanese coast and obtain a highly-resolved monitoring data that captures the spatio-temporal dynamics of several hundreds to thousands of fish species. Using this massive data, we are to depict when and where ecological regime shifts take place along Japanese coast.

The eDNA monitoring data would be further analyzed by using a modeling tool based on non-linear dynamical theory to test the hypothesis that an ecological regime shift is caused by a change in dynamical property of ecological systems. Furthermore, by using the modeling technique to evaluate system’s stability from time-series data, we are to develop a method with which one can forecast the ecological regime shift either earlier, more correctly or more sensitively.

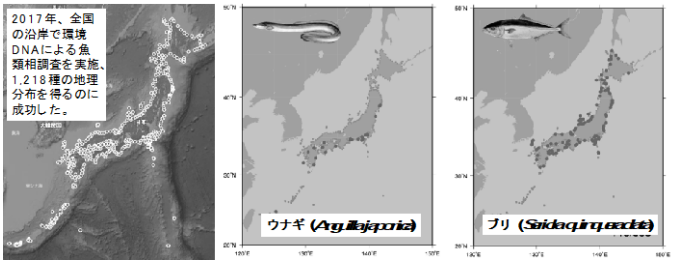

Fig. 1 One can get an advanced data of fish community along Japanese coast by using eDNA.

【Expected Research Achievements and Scientific Significance】

There are four expected achievements from the present project. We would (1) identify the spatio-temporal patterns of ecological regime along Japanese coast and (2) demonstrate if ecological regime shifts are related to changes in dynamical properties of ecological systems. We also develop methods (3) to judge if there is an on-going regime shift or (4) to forecast the future regime shift by using ecological monitoring data,

【Publications Relevant to the Project】

Miya et al. (2015) MiFish, a set of universal primers for metabarcoding environmental DNA from fishes: detection of > 230 species from aquarium tanks and coral reefs in the subtropical western North Pacific. Roy Soc Open Sci 2: 150088.
Ushio et al. (2018) Fluctuating interaction network and time-varying stability of a natural fish community. Nature 554: 360-363.

【Term of Project】 FY2019-2023

【Budget Allocation】 153,700 Thousand Yen

【Homepage Address and Other Contact Information】

https://www.lifesci.tohoku.ac.jp/research/teacher/detail---id-45517.html
michio.kondo.b8@tohoku.ac.jp