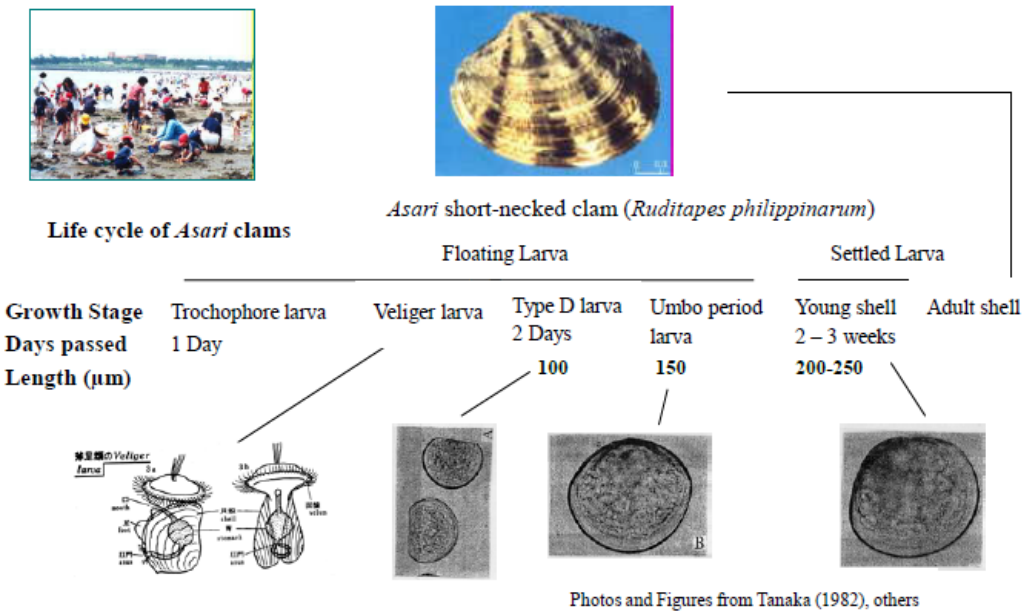
Reference: Research on *Asari* Clam Larvae

The substances carried by water currents include living organisms. Areas linked by living organisms are called ecosystem networks, a key concept for conservation and restoration of ocean and coastal ecosystems. An example of research on coastal area ecosystems is one conducted by the National Institute for Land and Infrastructure Management, among others, on *Asari* short-necked clams (*Ruditapes philippinarum*) in Tokyo Bay.

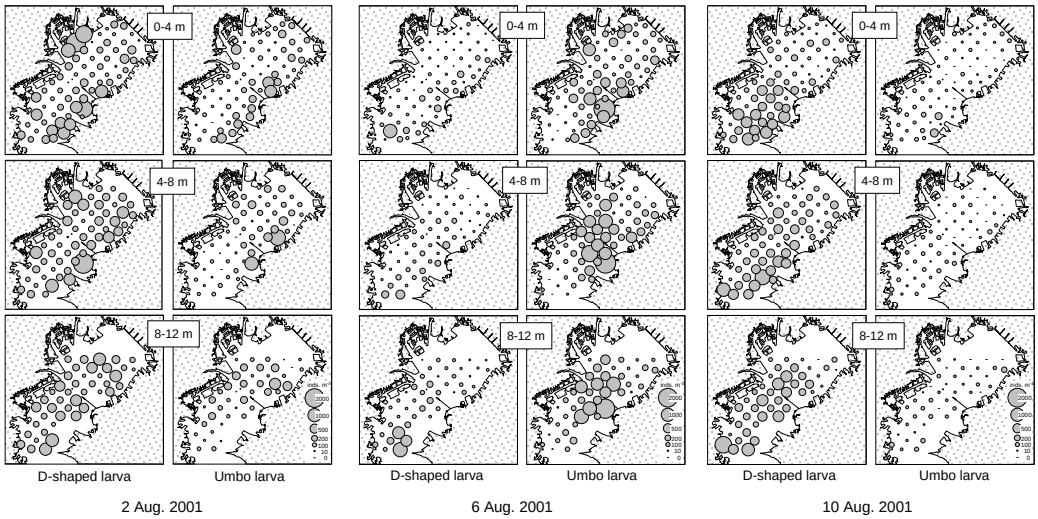
As is well known, *Asari* clams, which live in holes they dig in tidal flats, hatch eggs in the ocean during the spring and autumn through mass fertilization, after which the fertilized eggs float in the water and develop into larvae. The larvae progress over the 10 to 14 days they spend floating, and settle on the tidal flats as grown larvae, to begin their lives as *Asari* clams. In recent years, it was said that the reason for the huge decline in *Asari* clam harvests was due to the splitting up of the ecosystem network on the tidal flats, which to a certain extent are connected by these clams.



Life cycle of *Asari* clams (Kasuya, et. Al, 2003)

We decided to conduct research on how the *Asari* clam larvae are carried through looking at the amounts of floating *Asari* clams, and monitoring and analyzing the currents that carry them. First, we began by researching the distribution of the *Asari* clam larvae floating in the ocean. We took a boat to Tokyo Bay, drew buckets full of ocean water (200 liters), and while filtering the water through a net, used microscopes to look for larvae. It was a daunting process. However, we were helped by a new technology being developed at the time at the National Research Institute of Fisheries and Environment of Inland Sea (FEIS), which “magically” made it possible to dye just the *Asari* clams.

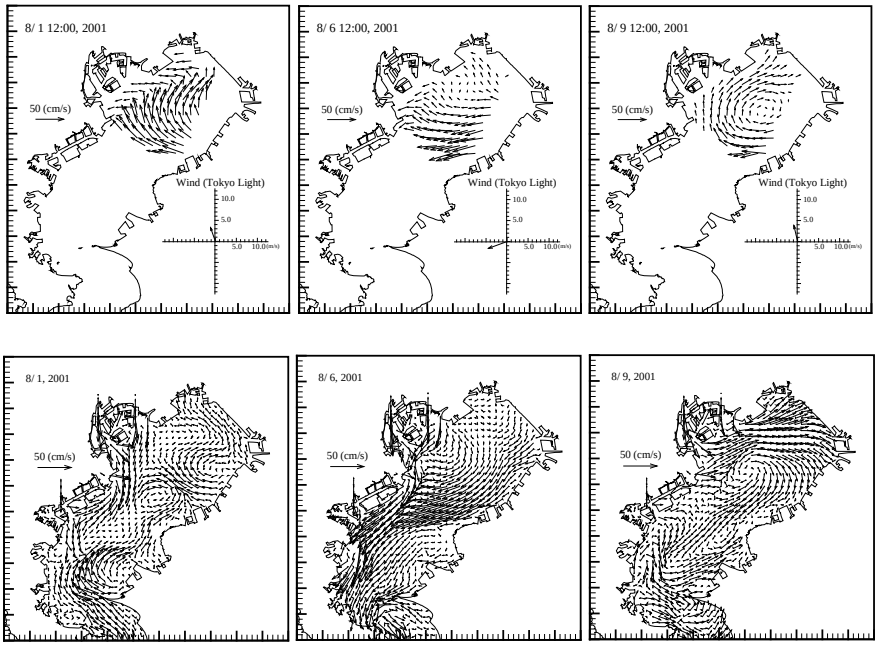
This was most welcome, as we conducted the research in summer and autumn, every three to four days, at 65 different observation points (upper, middle, and lower layers) to get ocean water, and differentiated them by size using two nets, in order to analyze 2,340 samples.



Distribution of *Asari* clam larvae

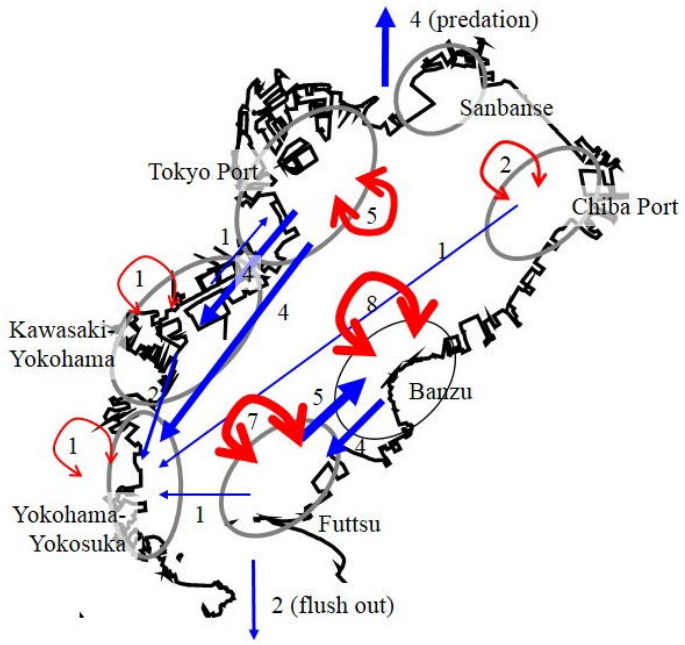
(From top) Study of three sets from August 2, 6 and 10 in 2001, in the order of upper layer, middle layer and lower layer. On the left is the Type D larvae (small) right before its final change, and on the right is the fully grown larvae (large).

Next came estimating the currents. While there were existing models that could mathematically simulate the currents, actual currents are influenced by various environmental changes including wind, temperature, water from rivers, and ocean currents flowing in. In this analysis, we needed to make sure to correctly reproduce the currents from when we gathered the *Asari* clam larvae. Here, we decided to use the ocean radar. This radar could send a high frequency signal (24.5 MHz) from a large-scale antenna on the land, and utilizing the refracting waves, gather an 80km^2 sample of the surface current. This was the second such device ever used in Japan, following the system developed by the Communications Research Laboratory (currently the National Institute of Information and Communications Technology). Through use of this technology, we were able to gather observational data on the detailed currents in deep areas in the bay, tune the calculation model, and precisely estimate the currents in the entire bay. We conducted an analysis based on the data gathered, and were able to create a visual of the network of *Asari* clam larvae in Tokyo Bay.



Observation and modeling of the detailed currents

Top: Measurements from ocean radars. Bottom: Calculations based on tuned mathematical models.

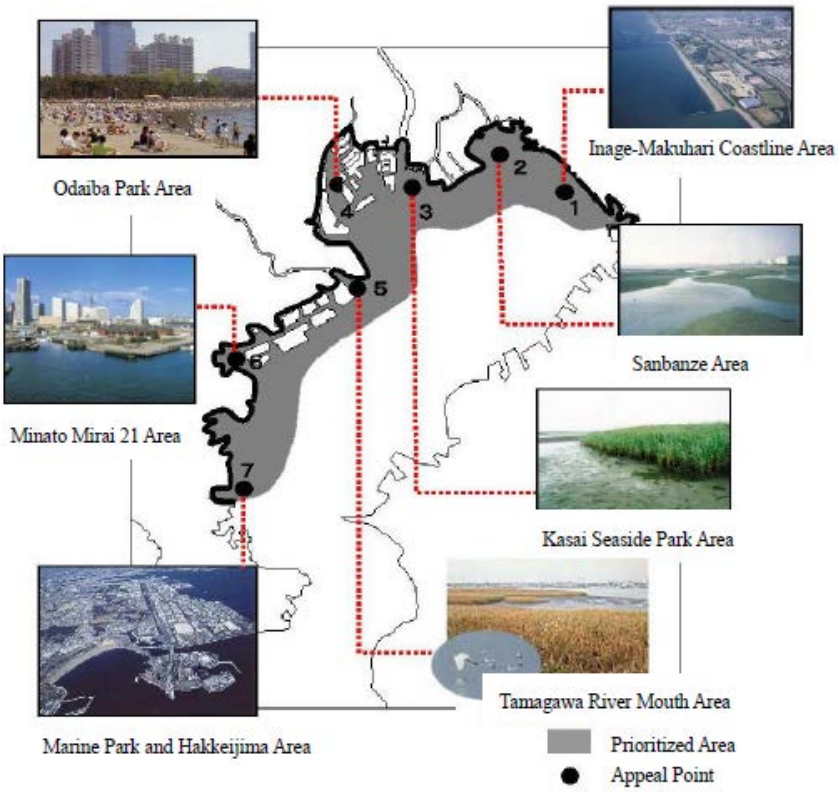


Presumed network of *Asari* clam larvae

The red arrows show the links inside the same tidal flat, the blue arrows show the links between different tidal flats, and the numbers show the relative strength of the links.

Source: Hinata & Furukawa (2005)

A diagram of clams was created through the connections among individuals from various fields, including fishermen as well as researchers in the fisheries, oceanography, and communication technology fields, and assessment and analysis experts. The diagram above shows that the link between the north and the southwest of Tokyo Bay, on the Tokyo and Kanagawa Prefecture side, is oriented mostly in one direction. This indicated to us that we would need to position tidal flats—the sizes do not matter but the number should be increased—to strengthen the network. In response to these research findings, the "Action Plan for Tokyo Bay Renaissance," which was developed in 2003 (with the second phase decided in 2013), established a "prioritized area" between inner Tokyo Bay and the western side as a restoration measure.



Prioritized Area in the "Action Plan for Tokyo Bay Renaissance"

(Developed in 2003, second phase decided in 2013)

Keita Furukawa

Director, Ocean Research and Development Department

References:

Hinata, H., & Furukawa, K. (2005). Ecological network linked by the planktonic larvae of the clam Ruditapes philippinarum in Tokyo Bay. In E. Wolanski (Ed.), The Environment in Asia Pacific Harbours.

Kasuya, T., Hamaguchi, M., Furukawa, K., & Hinata, H. (2003). Larval abundance, distribution, and size composition of planktonic larvae of the clam Ruditapes philippinarum in the fall season in Tokyo Bay. Res Rep Nat Int Land Infrastr Mang 12 (in Japanese)
http://www.nilim.go.jp/lab/bcg/siryou/rpn/rpn0012.htm

Kasuya, T., Hamaguchi, M., Furukawa, K., & Hinata, H. (2003). Larval abundance, distribution, and size composition of planktonic larvae of the clam Ruditapes philippinarum in the summer season in Tokyo Bay. Res Rep Nat Int Land Infrastr Mang 8 (in Japanese)
http://www.nilim.go.jp/lab/bcg/siryou/rpn/rpn0008.htm

Tokyo Bay Renaissance Promotion Council. (2003). Action plan for Tokyo Bay Renaissance. (in Japanese)
https://www1.kaiho.mlit.go.jp/KANKYO/TB_Renaissance/