



Founded in 1888 as the Marine Biological Laboratory of the University of California, San Diego, the MBL is a leading center for marine biological research and education. The MBL is a non-profit organization and is supported by the University of California, San Diego, and the National Science Foundation. The MBL is a member of the National Association of Marine Biological Laboratories (NAMBL).

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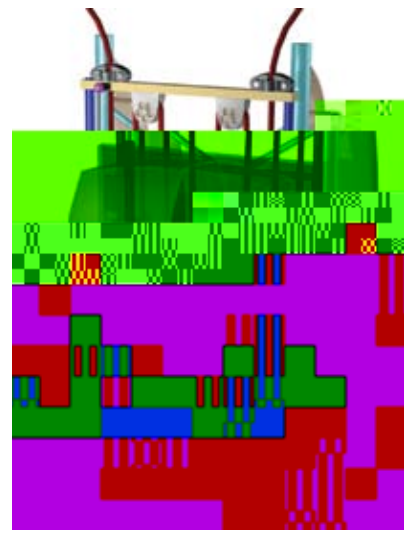
A watercolor painting provides a startling look at an icy Arctic that existed before climate change.

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A New PanArctic Approach

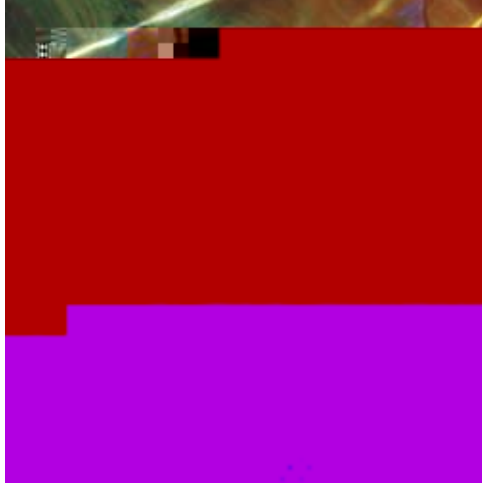




Tiny Larval Fish Living among Australia's Great Barrier Reef Spend the Early Weeks of Their Lives Swept up in Ocean Currents that Can Disperse them Far from their Birthplaces. Given such a life history, one might assume that these fish would be genetically homogeneous within their dispersal area. Yet diversity is found to be surprisingly high and individual reefs contain different fish populations. For such rich biodiversity to have evolved, some form of population isolation is required. Research published this year in the *Proceedings of the National Academy of Sciences* by MBL scientists Gabriele Gerlach and Jelle Atema and their colleagues showed that many fish species can discriminate odors in ocean currents and that some species can use home reef scent to return to the reefs where they were born. The homing behavior could support population isolation and slow genetic divergence, thus possibly favoring the ultimate formation of new species. "This research shows that the spatial distribution of these aquatic organisms is far from being random despite long larval dispersal stages of several weeks," says Gerlach. "Apparently, these larvae use sensory mechanisms to orientate and find their way to appropriate habitats or express successful homing behavior to their natal spawning sites. This might play a major role in processes of population separation and, eventually, of speciation." The research could also have important management implications not only for the Great Barrier Reef, but marine environments in general.

Tiny larval fish living among Australia's Great Barrier Reef spend the early weeks of their lives swept up in ocean currents that can disperse them far from their birthplaces. Given such a life history, one might assume that these fish would be genetically homogeneous within their dispersal area. Yet diversity is found to be surprisingly high and individual reefs contain different fish populations. For such rich biodiversity to have evolved, some form of population isolation is required. Research published this year in the *Proceedings of the National Academy of Sciences* by MBL scientists Gabriele Gerlach and Jelle Atema and their colleagues showed that many fish species can discriminate odors in ocean currents and that some species can use home reef scent to return to the reefs where they were born. The homing behavior could support population isolation and slow genetic divergence, thus possibly favoring the ultimate formation of new species. "This research shows that the spatial distribution of these aquatic organisms is far from being random despite long larval dispersal stages of several weeks," says Gerlach. "Apparently, these larvae use sensory mechanisms to orientate and find their way to appropriate habitats or express successful homing behavior to their natal spawning sites. This might play a major role in processes of population separation and, eventually, of speciation." The research could also have important management implications not only for the Great Barrier Reef, but marine environments in general.

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Balancing the Account

How do we measure the ecosystem services that nature provides? The MBL's Center for Ecosystem Services and Policy is working to answer this question.

Chuck Hopkins isn't your average outdoorsman. Whenever this avid hiker, boater, skier, and swimmer is in nature, he takes in a lot more than just the scenery. What he sees is the literal value of what nature provides us for free: oxygen to breathe, water to drink, and natural resources to harvest.

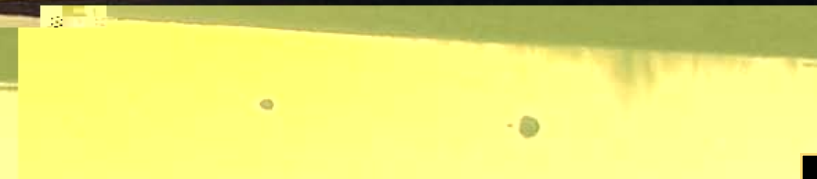
In fact, Hopkins, a senior scientist with the MBL's Ecosystems Center, has recently helped create a novel way to evaluate the natural resources too many of us take for granted. In a paper published last February in *BioScience*, he and several colleagues describe a balance-sheet approach known as "ecosystem services-based management," a promising new tool that links ecology and economics.

The new method assigns absolute values to the services that ecosystems provide to society and the human actions that degrade these services. "It's a way for natural resource managers to quantify the change in value of ecosystem services so they can base their actions on minimizing the value of service reductions," says Hopkins.

One area that could benefit from this approach is Plum Island Sound in northeastern Massachusetts, where Hopkins is the lead principal investigator on the Plum Island Ecosystem Long Term Ecological Research project.

Since the mid-1980s, MBL Ecosystems Center scientists and their collaborators have been documenting environmental changes in the Plum Island Sound estuary, which is heavily affected by rapid

rates of development. The suburbanization is occurring in two watersheds that run through 26 towns and drain into the sound.



Evidence that Earth's ecosystems are changing is mounting to say the least. One way to understand the effects of these changes is through extended scientific assessments known as Long Term Ecological Research (LTER) projects. With funding from the National Science Foundation, LTER scientists study model ecosystems over many years, then use math and computer modeling to predict how environmental changes will affect them—and similar ecosystems—in the future. Such research is crucial to the wise management of our planet for the benefit of future generations.

MBL Ecosystems Center scientists currently have leadership roles in LTER projects located in the Alaskan Arctic (Toolik LhRs,cas

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...with

Hugh Ducklow

incoming director of the MBL
Ecosystems Center



Hugh Ducklow is a marine ecologist who studies plankton dynamics and biogeochemistry and works regularly at Palmer Station in Antarctica. In May he will become the director of the MBL's Ecosystems Center. He is currently the Glucksman Professor of Marine Science at the Virginia Institute of Marine Science (VIMS) at the College of William and Mary. His research centers on the interactions between climate change and ecosystem function, especially on the Antarctic Peninsula, a region that is warming especially fast. Hugh has conducted research in the North Atlantic, central North Pacific, equatorial Pacific, Arabian Sea, Red Sea, Southern Ocean, Great Barrier Reef, Caribbean, Black Sea, Baltic Sea, Hudson River, and Chesapeake Bay.

MBL Why should we study polar regions that most people don't think much about on a regular basis?

HD The polar regions are important for a number of reasons. First, they are important for understanding the global climate system. The polar regions are the only places on Earth where the atmosphere and the ocean are in direct contact. This means that the polar regions are the only places where we can study the interactions between the atmosphere and the ocean in a direct way. Second, the polar regions are important for understanding the global carbon cycle. The polar regions are the only places on Earth where the atmosphere and the ocean are in direct contact. This means that the polar regions are the only places where we can study the interactions between the atmosphere and the ocean in a direct way. Third, the polar regions are important for understanding the global water cycle. The polar regions are the only places on Earth where the atmosphere and the ocean are in direct contact. This means that the polar regions are the only places where we can study the interactions between the atmosphere and the ocean in a direct way.

MBL What is the importance of the International Polar Year and how is the MBL participating?

HD The International Polar Year (IPY) is a global effort to study the polar regions. The IPY is the only time when scientists from all over the world come together to study the polar regions. The MBL is participating in the IPY by sending a research vessel to the Arctic. The MBL is also participating in the IPY by sending a research vessel to the Antarctic. The MBL is also participating in the IPY by sending a research vessel to the Arctic. The MBL is also participating in the IPY by sending a research vessel to the Antarctic. The MBL is also participating in the IPY by sending a research vessel to the Arctic. The MBL is also participating in the IPY by sending a research vessel to the Antarctic.

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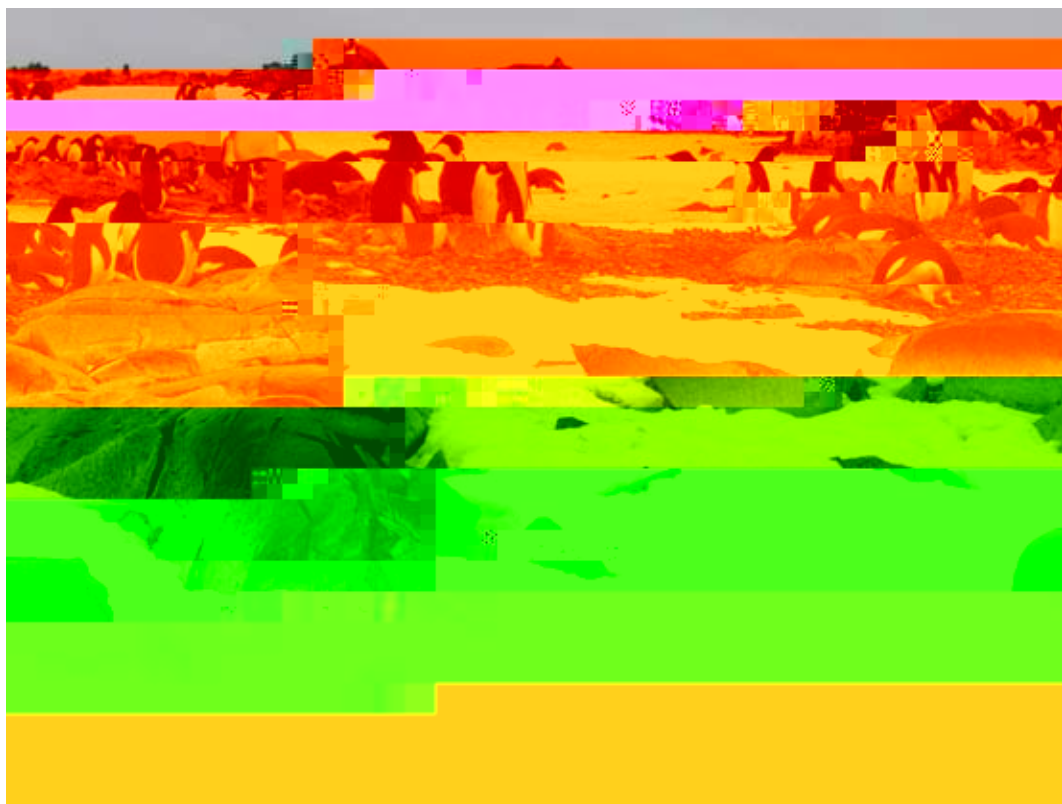
the same), and the fact that the $\mathbf{f}$ vector is not a constant vector, but a function of time, $\mathbf{f} = \mathbf{f}(t)$. The fact that the $\mathbf{f}$ vector is a function of time is a key feature of the system, and it is this that makes the system non-linear. The fact that the $\mathbf{f}$ vector is a function of time is a key feature of the system, and it is this that makes the system non-linear.

MBL Your research is based in Antarctica. What do you study there, how did you get interested in this work, and is it really as cold as it looks?

HD I am interested in the dynamics of the Antarctic ecosystem, and in particular, the dynamics of the krill population. Krill are a key component of the Antarctic food web, and they play a crucial role in the transfer of energy from primary producers to higher trophic levels. I am interested in understanding how the krill population is affected by changes in the environment, and how these changes are reflected in the dynamics of the ecosystem. I am also interested in understanding the role of krill in the carbon cycle, and how they contribute to the sequestration of carbon in the ocean. I am interested in understanding the dynamics of the krill population, and how they are affected by changes in the environment. I am also interested in understanding the role of krill in the carbon cycle, and how they contribute to the sequestration of carbon in the ocean.

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“[Antarctica] is changing at all levels, from melting glaciers and shrinking sea ice to changes in phytoplankton and zooplankton, to declining populations of ice-adapted Adèle penguins, seals, and whales.”



MBL As incoming director, what do you think are the Ecosystems Center's strengths and what do you hope to accomplish in your new role?

HD The Ecosystems Center is a world leader in understanding the dynamics of the Earth's ecosystems, and in particular, the dynamics of the Antarctic ecosystem. I am excited to join the Center, and I am looking forward to working with the staff and students to advance our understanding of the Antarctic ecosystem. I am also looking forward to working with the public to raise awareness of the importance of the Antarctic ecosystem, and the need to protect it.



ACCOLADES

- MBL Corporation member **Thomas D. Pollard**, chair and Sterling Professor of Molecular, Cellular and Developmental Biology at Yale University, and former MBL Physiology course faculty member **Joan Steitz**, Sterling Professor of Molecular Biophysics and Biochemistry and a Howard Hughes Medical Institute Investigator at Yale, received the 2006 Gairdner International Awards, which are among the most prestigious in science.
- MBL Corporation member and former Physiology course director **Joel Rosenbaum** (Yale University) received the



Figure 1. *Adventures by Sea from Art of Old Time*

The painting is a reproduction of a work by an unknown artist, titled *Adventures by Sea from Art of Old Time*. It is a landscape painting, depicting a seascape with several large sailing ships on the horizon. The sky is filled with soft, white clouds, and the water is a deep blue. The foreground is dominated by a dense, colorful, and abstract pattern of small, repeating geometric shapes, creating a textured, almost mosaic-like effect. The overall style is a blend of traditional maritime painting and modern abstract art. The painting is a reproduction of a work by an unknown artist, titled *Adventures by Sea from Art of Old Time*. It is a landscape painting, depicting a seascape with several large sailing ships on the horizon. The sky is filled with soft, white clouds, and the water is a deep blue. The foreground is dominated by a dense, colorful, and abstract pattern of small, repeating geometric shapes, creating a textured, almost mosaic-like effect. The overall style is a blend of traditional maritime painting and modern abstract art.

The **Catalyst** is a **MBL** (Molecular Biology Laboratory) that is used to study the effects of various factors on the growth and development of plants. It is a specialized laboratory that is equipped with various instruments and tools that are used to study the effects of various factors on the growth and development of plants.

Biological Disposition

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Figure 1 illustrates the experimental setup. A subject is seated at a table, viewing a video screen. A video camera is positioned above the screen. A horizontal bar is placed on the table, with a vertical rod attached to it. The rod is connected to a motor unit, which is connected to a power source. The motor unit is also connected to a video camera. The video camera is connected to a video screen. The video screen displays the position of the rod. The subject is instructed to move the rod to a target position on the video screen.