WHAT LIES BENEATH

Marine Spatial Mapping and the Identification of the Arctic Jewels

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WITH A POPULATION ROUNDED 18,000, bowheads seem to be doing well, at least in the short term. Warmer temperatures and receding sea ice, caused by a changing climate, may open up more food opportunities for the whales, which feed mostly on krill and other tiny marine crustaceans.

“For now, it’s a great time to be a bowhead,” says Sue Moore, a biological oceanographer with the Marine Ecosystems Division at the National Oceanic and Atmospheric Administration (NOAA). “We are actually looking at a more productive ocean.”

BUT MELTING SEA ICE AND OTHER CLIMATE CHANGE IMPACTS ALSO HAVE SERIOUS AND LONG-TERM DOWNSIDES. IN ADDITION TO THE STRESS PLACED ON POLAR BEARS AND OTHER ICE-DEPENDENT ANIMALS, THIS MORE OPEN ARCTIC OCEAN ALSO INVITES A GREATER HUMAN PRESENCE. INCREASED OFFSHORE OIL AND GAS EXPLORATION AND DEVELOPMENT, SHIPPING TRAFFIC, AND EXPANDED COMMERCIAL FISHERIES WILL AFFECT ARCTIC ECOSYSTEMS AND WILDLIFE, INCLUDING BOWHEADS.

One satellite tracking study—conducted by a consortium that includes the US Bureau of Ocean Energy Management, the Alaska Eskimo Whaling Commission, and the Alaska Department of Fish and Game—showed that areas of interest for oil and gas overlapped in time and space with bowhead summer feeding zones near the Tuktoyaktuk Peninsula in Canada, along their fall migration corridor. The research demonstrated that in one season, a single bowhead whale might pass through active oil and gas lease areas in Canada, Alaska and Russia. In fact, says Alaska Department of Fish and Game’s Lori Quakenbush, a marine mammal biologist, “One tagged whale went through four active industrial areas in 2006, two of which were conducting seismic operations when the whale passed by.”

In coming decades, greater ship traffic is anticipated as sea ice becomes less of an obstacle to summertime navigation. Vessels using both the Northern Sea shipping route and the Northwest Passage will have greater seasonal leeway to travel through the Bering Strait. Ship strikes (collisions between ships and animals) and noise disturbance are major concerns not only for bowheads, but for many other species that use this marine mammal superhighway.

Oil and gas activities also create the potential for oil spills. “With humans, unfortunately, accidents are often just a matter of time,” says NOAA’s Moore.

In this context of rapid change, several environmental groups recognized that there is no time to waste. Together and independently, WWF, the Ocean Conservancy, Oceana, Pew Environment Group and Audubon set out to better understand these changes and their implications in order to advise US decision makers about areas they believe should be off limits for future offshore oil leasing and drilling.

DEFINING THE ARCTIC JEWELS

One of WWF’s contributions to this effort has been an extensive mapping process for the Bering, Beaufort and Chukchi seas, to identify those areas that should become the focus of conservation actions.

“Climate change has already altered the Arctic, and before industrialization affects it too we need to put in place protections, policies and practices that will allow for resilient ecosystems and communities,” says Margaret Williams, managing director of the WWF-US Arctic field program. “These ‘Arctic Jewels’ are areas that are important now—and are likely to remain so in the future—for people, wildlife communities and ecological processes like migrations.”
Defining what makes a place an Arctic Jewel is not a simple process. A key approach is known as RACER (Rapid Assessment of Circum-Arctic Ecosystem Resilience), a technique pioneered by Martin Sommerkorn, head of conservation at WWF’s Global Arctic Program, to help identify Arctic places of exceptional productivity and biological diversity. As part of a process to determine an area’s resilience in response to the kind of rapid change facing the Arctic, RACER helps us understand what makes these places exceptional by assessing what is actually driving that productivity—factors such as the shape of the seafloor, seasonal ice cover, winds, water circulation and currents, sea surface temperature, and salinity.

For example, sea ice, water circulation and currents, and sea surface temperatures are all ingredients that drive the unusual productivity and diversity found in the Bering Strait. Nutrient-rich Bering Sea waters flow north through the strait into the Chukchi Sea, where three ocean currents meet. As the sea ice recedes in the spring, sunlight stimulates massive phytoplankton blooms along the ice edge, creating an abundant food source up and down the water column, from surface to seafloor. This makes the area along the ice edge a crucial feeding hotspot, not only for the whales and other marine mammals that migrate through the strait, but also for millions of seabirds, such as black-legged kittiwakes, common and thick-billed murrens, horned puffins and eiders.

In the eastern Chukchi Sea corridor, high productivity is driven by the convergence of water circulation patterns and wind and sea ice dynamics, which creates areas of persistent open water—called polynyas—that are critical for wildlife.

One of the most intriguing drivers of ocean productivity and diversity is bathymetry—or the topography of the ocean floor. For example, the Barrow Canyon, an undersea channel located at the boundary of the Beaufort and Chukchi seas off Point Barrow in Alaska, attracts a high diversity of wildlife. Here, the undersea currents and the shape of the canyon itself cause an upwelling of nutrient-rich water to the surface. That fertile mix benefits plankton and plankton predators, creating a nourishing stew on which a variety of birds and marine mammals feed.

In the Chukchi Sea, Hanna Shoal’s underwater contours drive ecological diversity as well. The shallow topography around the shoal diverts warm water masses flowing northward from the Bering Sea and holds on to colder water. As a result, sea ice persists there for an extended period of time each spring. Although it is beginning to show the effects of the warming climate, Hanna Shoal still acts as a last ice refuge in the summer season for animals that feed on the bottom of the continental shelf, particularly walrus and bearded seals. Polar bears use Hanna Shoal as well.

Making a Better Map

Not many people get the opportunity to directly experience these remote locales, but Audubon Alaska’s director of conservation science, Melanie Smith, got to see them all. After years of researching data on sea ice, bathymetry, fish, birds, marine mammals, energy development and more—mostly from behind her desk in Anchorage—Smith produced Arctic Marine Synthesis: Atlas of the Chukchi and Beaufort Seas. Then, in October 2012, she seized the opportunity to leave her office behind. She joined a three-week scientific expedition to the Arctic with the US Coast Guard Cutter Healy, an icebreaker on which she served as a seabird observer.

“I remember passing through an area that was relatively quiet; I didn’t see much other than several gulls flying by,” says Smith. “And then approaching the Barrow Canyon area, I started seeing more and more wildlife—eiders, yellow-billed loons and bowhead whales. The diversity and abundance of life went up. You can tell there is something special there and that, ecologically, you have crossed a line.”

After traveling 5,200 miles to see Barrow and other Arctic areas with her own eyes, Smith became confident that she’d helped correctly identify important places. “There is no way to perfectly draw a line in the ocean,” she says, “but my sense was when you come into these regions there is something different and important about them.” The mapping process works to make sure those kinds of experiential observations are also recognized.

But that complexity is only one part of what makes determining the conservation-critical regions of the Arctic and drawing those lines on a map such intricate exercises. While this article
focusing on marine areas, the impact of the land on ocean resources also can’t be ignored. Says WWF’s Sommerkorn, “We know a lot about areas around research stations, cities, towns and villages, but we don’t know a lot about the free land that is so vast between these points, and how they interact with the sea; RACER is also helping us identify those places where the land and sea work together to create productive biological areas that have the ability to adapt to climate change.”

The approach meets part of this challenge by using remote sensing to look for highly productive sites in a spatially continuous and standardized way, rather than relying on spot measurements near research stations or human settlements.

For instance, remote sensing can provide satellite images that reveal the density of chlorophyll at the water’s surface—an important measure of primary productivity and the principal building block of organic matter in an ecosystem. Bathymetric information, on the other hand, focuses on water depth measurements that show canyons, shelf breaks and other features of the ocean floor that play a role in driving productivity and diversity. But these indicators of likely abundance are not enough. Hence, Smith’s trip to Barrow Canyon, and other in-person verification trips.

Bruce Robson, a marine mammal researcher and contract biologist who led WWF’s Bering-Beaufort-Chukchi mapping project, adds, “Productivity, especially below the surface, is not always picked up by satellite remote sensing.”

So for example, Robson incorporated additional data about marine mammal feeding concentrations and migration corridors, haul-out areas for ice-dependent seals, seabird nesting colonies, previously designated “Important Bird Areas,” distribution of fish species and invertebrates, and other sources—all to supplement the data RACER-type analyses provide. “Mapping is not just about identifying important places,” he explains, “but also understanding the connectivity between them and how species are moving across these regions.” Much like those bowhead whales.

All this data serves to build a unified and informed picture for scientists to review. “At some point,” adds Sommerkorn, “you have to make assumptions about what constitutes a critical mass [of productivity] and how you draw a circle around that place.”

AND THEN THERE’S CLIMATE CHANGE, in the face of which some of the features that define the Arctic Jewels may not have the same characteristics they do now in another 50-100 years.

That’s another reason WWF brought the RACER technique into the mix: it includes a reduced-scale regional analysis derived from global climate models to estimate whether those productivity-enhancing features will persist in the future despite the impacts of climate change on sea surface temperature, sea ice, salinity, rain and other factors. In short, it helps to predict whether the sites we protect today will remain diverse and productive in the future.

In January 2014, the WWF team presented preliminary results of its analysis to a group of scientists gathered for a one-day workshop. Together they carefully reviewed each feature, the rationale for its current importance and the likelihood that it would remain important given the projected impacts of climate change. The end result was a robust map of the key features in the Bering, Beaufort, and Chukchi Seas which are now—and are likely to continue to be—the main drivers of productivity and diversity. WWF is now using this map to inform our selection of priority conservation areas in the Bering, Beaufort and Chukchi Seas.

FROM MAPPING TO MAKING A DIFFERENCE

But this scientific mapping process is only the first step toward the development of actual conservation strategies. For bowhead whales, for example, the new information could suggest the establishment of ship traffic lanes and vessel speed regulations in the Bering Strait, the establishment of strategic closures of important habitat to industrial activities, and the regulation of underwater noise sources to reduce the sonic pressure on whales.

Securing such advances, however, takes more than just scientific recommendations. “Maps are a really important tool for beginning to understand where you need to protect places, but then fundamentally these are social and political decisions,” notes J. Charles Fox, program director for Oceans 5, a funders’ collaborative dedicated to protecting the world’s oceans, with a special focus on establishing marine reserves to control overfishing.

“We need to select sites that are important ecologically and biologically,” continues Fox, “as well as the sites that are viable politically. We have to ask, ‘Is it doable?’ And, ‘Do we actually have the political will to succeed?’”

As Audubon’s Melanie Smith emphasizes, “Decisions are being made about the Arctic, and it is in our best interest to understand what is important and what the human influences are, and do conservation planning accordingly.”

“Scientific data,” Margaret Williams reiterates. “Empirical observations. Hard-won expertise. That’s what WWF and our partners can provide.” Now, she agrees, we must get that gathered insight into the hands of the right people.

Thanks to the coordinated efforts of the conservation groups involved in the project, we can now give those with the power to protect the Arctic a much clearer picture of where to focus their efforts—and a better sense of exactly what’s at stake.