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The polar bear (possible hybrid pictured) is one of several species vulnerable to hybridization.

The Arctic melting pot

Hybridization in polar species could hit biodiversity hard, say **Brendan Kelly**, **Andrew Whiteley** and **David Tallmon**.

In 2006, a white bear with patches of brown fur was shot by hunters in the Arctic. DNA tests confirmed what many suspected — it was a hybrid of a polar bear and a grizzly. A media frenzy quoted biologists as saying that although they knew in theory such cross-breeding could happen, they didn't expect to see it in the wild. In 2010, another hybrid was killed by a hunter in the western Canadian Arctic. This time, the animal was a second-generation cross — its mother was a hybrid and its father a grizzly. More cases are probably out there.

Biologists should not be surprised. There have been hints of Arctic hybrids before. In the late 1980s, a whale thought to be a narwhal–beluga mix was found in west Greenland. In 2009, an apparent bowhead–right-whale hybrid was photographed in the Bering Sea, between Alaska and Russia. Dall's porpoises are known to be mating with harbour porpoises off the coast of British Columbia, and seal hybrids have been identified in museum specimens and in the wild.

These are just the first of many hybridizations that will threaten polar biodiversity. Rapidly melting Arctic sea ice imperils species through interbreeding as well as through habitat loss. As more isolated populations and species come into contact, they will mate, hybrids will form and rare species are likely to go extinct. As the genomes of species become mixed, adaptive gene combinations will be lost.

Researchers have little idea how much hybridization is occurring, let alone how it will affect populations. Plans must be developed immediately to monitor the genetics of Arctic animals and to deal with hybrids before currently discrete populations merge and at-risk species are bred out of existence.

We have counted at least 34 possible hybridizations between discrete populations, species and genera of Arctic and near-Arctic marine mammals (see Supplementary Information). Of the 22 species involved, 14 are listed — or are candidates for listing — as endangered, threatened or of special concern by one or more nations. Twelve cases are of hybridization between different species — half involving crosses between what are normally classified as distinct genera. Twenty-two cases involve isolated populations at risk of intra-species mixing, nine of which are classified as distinct subspecies.

The Arctic Ocean is predicted to be ice-free in summer before the end of the century, removing a continent-sized barrier to interbreeding. Polar bears are spending more time in the same areas as grizzlies; seals and whales currently isolated by sea ice will soon be likely to share the same waters.

Not all cross-species matings will produce viable — or indeed any — offspring. The chance is enhanced in Arctic marine mammals, because their number of chromosomes has changed little over time. There is evidence of hybridization across species (such as between spotted and harbour seals) as well as across genera (such as harp and hooded seals).

Hybridization is not necessarily a bad thing. It has been an important source of evolutionary novelty. For example, a new species of chub originated in the Colorado River before the presence of humans, from the hybridization of two other species. But hybridization driven by human activities tends to occur quickly and to reduce genomic and species diversity. When mallard ducks were introduced to New Zealand in the 1860s, they began mating with native grey ducks. Now few, if any, pure native populations remain.

Diversity loss may be minor if, say, North Pacific and North Atlantic minke whale subspecies interbreed in an Arctic with diminished ice. Other crosses will be more problematic. Interbreeding between the North Pacific right whale, of which there are probably fewer than 200, and the more numerous bowhead whale could quickly push the former to extinction. If polar bears survive climate change in secluded refuges — which is far from certain — interbreeding could be the final straw.

Cross-breeding might affect social and ecological interactions. The apparent narwhal–beluga hybrid discovered in Greenland had teeth combining qualities of each species, but lacked the narwhal's tusk — an important determinant of narwhal breeding success. Polar–grizzly hybrid bears in a German zoo exhibited behaviour associated with seal hunting, but not the strong swimming abilities of polar bears. First-generation crosses can have 'hybrid vigour', but later generations are likely to be less fit than their ancestors ('outbreeding depression').

The International Union for the Conservation of Nature should develop a comprehensive policy for managing hybrids, including determining when it is practical to prevent or limit hybridizations. Red wolf and coyote hybrids, for example, have been culled in the United States in the past decade to help preserve distinct species.

Researchers should combine models of sea-ice loss, oceanography and landscape genomics to predict when and where hybridization is most likely, and to monitor the genetics of at-risk populations. National and tribal governments should work together: some indigenous groups actively monitor the harvests of Arctic marine mammals, and they could collect genetic samples in remote areas. The rapid disappearance of sea ice leaves little time to lose. ■

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Further reading and Supplementary Information accompanies this article at go.nature.com/h4bksj