for GIS projects. Keeping in mind this limited aim, the authors deliver their message clearly and in a very comprehensive manner. Images are gaining increasing importance in mapping projects and GIS databases and these pictures can, literally, be worth more than a thousand words when it comes to mapmaking.

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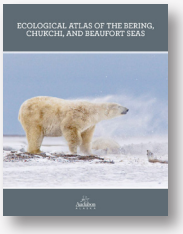
ECOLOGICAL ATLAS OF THE BERING, CHUKCHI, AND BEAUFORT SEAS, SECOND EDITION



Edited by Melanie A. Smith, Max S. Goldman, Erika J. Knight, and Jon J. Warrenchuk; Cartography by Daniel P. Huffman

Audubon Alaska, 2017

332 pages, 100+ maps, and 100+ illustrations; $105, softcover.

Free PDF download: ak.audubon.org/conservation/download-ecological-atlas-bering-chukchi-and-beaufort-seas

Review by: Daniel Cole, Smithsonian Institution

This handsome book begins with an invitation to imagine various scenes of human-wildlife interaction in the Arctic. The editors, led by Melanie Smith of Audubon Alaska, want the readers to explore these and other Arctic marine scenes. Their goal, as set out in the opening paragraphs of the Introduction, "is to create a comprehensive, trans-boundary atlas that represents the current state of knowledge on subjects ranging from physical oceanography to species ecology to human uses" (2). This review will evaluate whether or not the atlas, and especially its maps, has achieved this goal.

The rest of the Introduction addresses a range of basic issues, including how the Arctic is managed, both nationally and internationally. It also provides a review of historic cartographic endeavors by the National Oceanic and Atmospheric Administration (NOAA) and by Audubon Alaska, followed by a discussion of mapping methods and challenges that includes issues of data quality and knowledge gaps. The section Use of Traditional Knowledge and Subsistence Datasets tells how the atlas content was reviewed by Bering Strait tribes, and is a critical inclusion.

The first map in the atlas is on page 9, and is a map of North America made in 1812 that shows the Bering and the southern Chukchi Seas, but nothing at all of the Beaufort. An accompanying inset of a Google Earth-like

image of the region suggests how much we have learned about the geography of the area in the past two hundred years. One criticism that must be noted is that while the editors mention the David Rumsey Map Collection, neither a cartographer nor a map issuer is credited for the 1812 map. This lapse is unfortunate and inexplicable.

Daniel Huffman's well-rendered two-page base map completes the introductory chapter. This map provides topographic and bathymetric relief, political boundaries, the Arctic Council boundary, roads, rivers, ferry routes, villages, and cities, plus a line indicating the extent of Alaskan submerged lands. While the map is effectively and properly labeled, the addition of a legend would help the reader.

Following the Introduction are two chapters focused, respectively, on the Physical and Biological Settings, followed by four chapters that concern the Fishes, Birds, Mammals, and Human Uses of the region. Things are wrapped up with a six-page Conservation Summary.

All of the chapters except the Introduction and Conservation Summary open with a table of topical sections, with each entry represented by a small map. Each section, however, contains numerous other one-quarter to full-page maps as well as a number of satellite images, and because there is no comprehensive map index, finding any particular map requires the reader to peruse the atlas.

Chapter 2, Physical Setting, opens with maps of ocean currents in the three seas, with notations on flow direction, upwelling, stream discharges, summer and winter ice extents for 2006, and interpolated measurements of carbon depletion in marine sediments. A look at sea ice follows, with maps of old ice (ice that has survived at least one melt season) and of ice concentrations for 2016. A pair of two-page maps shows long-term changes in seasonal ice advance and retreat over the period from 1850 to 2015. Varied line symbols include a dotted line for 1850, dashed lines for 30-year monthly medians from 1980 through 2010, and thick, fuzzy lines for 10-year monthly medians between 2006 and 2015. Polygons symbolize the presence of polynyas, landfast ice, and mixtures of the two. There are also maps of marine ecoregions, Arctic air temperature differences, and sea ice concentration anomalies at the 2016 annual Arctic sea ice area minimum (September) and the 2017 annual Arctic sea ice extent maximum (March). Forty-five-year averages of shallow and deep-sea water temperature, sea ice concentration, ice phytoplankton concentration, micro- and macro-zooplankton concentrations, and benthic infaunal biomass concentration are placed side by side with maps of the same topics showing projections for 2040. These maps are appropriately colored either in light-to-dark tones or in diverging colors above and below zero, depending on the data. The last map in this chapter effectively combines mean sea level air pressure in diverging colors with a three-class set of arrows indicating wind speed.

The third chapter, Biological Setting, begins by addressing primary productivity. A Landsat 8 image shows a phytoplankton bloom around the Pribilof Islands. On the next two pages is a map of maximum integrated chlorophyll contoured with values from 2 through 900 milligrams per square meter. Sampling points are indicated, along with lightly shaded mean sea ice extents for March, May, June, July, and September. An inset of a satellite image that lacks a caption or any geographic connection to the text is provided, and seems to be of the Nunivak Island area. Logically following this is a section on zooplankton with a two-page contour map of average annual total zooplankton carbon mass, measured in milligrams of carbon per cubic meter. The lightly toned ice extents are again provided, but the sampling points are not. Next is another two-page map depicting the relative benthic biomass for the three seas, with both ice extents and lines indicating the limits of contributing surveys, plus point locations for documented coral and sponge gardens in the Aleutian Islands. This chapter is completed with distribution maps of several crab species, based primarily on trawl density.

Chapter 4 maps eight different fish types, including the *Osmeridae* forage fish family (which includes capelin, eulachon, and smelt), Pacific herring, walleye pollock, various cods (Pacific, Arctic, and saffron), Atka mackerel (which are limited to Aleutian waters), yellowfin sole, Pacific halibut, and Pacific salmon (Chinook, sockeye, coho, pink, and chum). Factors of interest illustrated include distributions and concentrations; wintering, feeding, spawning, and nursery grounds; nesting sites, and Essential Fish Habitat (EFH) areas, plus winter and summer migration routes. Some terminology is used inconsistently across the maps; for example, I question the use of the label "Regular Use" on the Pacific herring map as opposed to "General Distribution", which was used on some of the other maps. If there is a reason for using the different term, it is not obvious.

No one should be surprised that the 94-page Chapter 5, Birds, is the longest chapter in this Audubon atlas. The first map concerns Marine Bird Colonies across the three seas and uses pie chart point symbols with population size graduations and proportional species sectors. The six size classes range from fewer than twenty thousand to over five hundred thousand birds, and the pies are divided into up to five species categories (puffins, murres, auklets, storm petrels, and other). The ten largest colonies have a heavy black line around the pies and have small numeric tags indicating their size (from over six hundred thousand to over five million). With only four pies that are of the largest size but that are untagged, and given the numeric tags, I doubt that the black line is necessary. Wisely, the smallest circles are not shown as pies, and the vast majority, but not all, of the points are pulled away from their often densely clustered locations using leaders. However, nine of these leaders near the bottom of the page, including one associated with one of the larger colonies, point to indeterminate locations lost in the page binding. The locations are obscure even in the PDF version of the atlas, since that area of the map fades into a white "Incomplete Data" zone in the Gulf of Alaska. Overlaying the pie areas with the vector shorelines allows both the charts and the map to work independently without being too visually noisy.

This map is immediately followed by four half-page dasymetric maps of foraging guilds (surface planktivores, surface piscivores, diving planktivores, and diving piscivores) that use an effective yellow-to-red color scheme progressively indicating birds per square kilometer, along with small black dots indicating colony locations. Next is a two-page map of Important Bird Areas (IBAs) throughout the three-sea region. This map depicts IBAs as significant at the global (light red), continental (light orange), and state (light greenish-yellow) levels. Given that the vast majority of IBAs are in the global category, presenting the continental and state areas in brighter colors would have been warranted. This map is followed by two half-page maps, the first of annual bird density in shades of red over land and light yellow through shades of green over water, and the second of the number of surveys made at locations across the study area. These two maps together nicely illustrate how density estimates are based on collecting effort, and should not be confused with simple presence-absence. On the facing page are four one-eighth-page maps illustrating winter, spring, summer, and fall bird densities.

After these general studies, the atlas authors tackle individual species maps: starting with the King Eider, followed by the Spectacled Eider, Common Eider, Steller's Eider, Long-tailed Duck, Yellow-billed Loon, and the Red-throated Loon. Each of these two-page maps depicts regions of breeding, wintering, staging, and molting (the Loon maps do not include this last category) in four colors, fall and spring migration routes, plus approximations of the range extents over the Bering Sea and Arctic Ocean. General Marine Areas are also shown.

These give way to a series of half-page maps of the Red-faced Cormorant, Red-necked Phalarope, Red Phalarope, Aleutian Tern, Red-legged Kittiwake, Black-legged Kittiwake, Ivory Gull, Common Murre, Thick-billed Murre, Horned Puffin, Tufted Puffin, Parakeet Auklet, Crested Auklet, Whiskered Auklet, Least Auklet, Short-tailed Albatross, and Shearwaters. Most of these maps include five-class graduated circles for colony sizes, with major colonies emphasized, overlaying areas of regular use and concentration, plus dashed lines of approximate range extents. Colony size circles are not shown on the maps of the Phalaropes, but these maps do depict areas of breeding and non-breeding habitats by regular use and concentration along with the approximate range extents and spring and fall migration routes. The Ivory Gull, Albatross, and Shearwater maps are much the same except that they do not include any differentiation between breeding and non-breeding habitats. A few extra small maps illustrate the at-sea utilization distributions of the Kittiwakes, and the Pacific-wide seasonal migration routes of the Short-tailed and Sooty Shearwaters.

Chapter 6 deals with twelve species of mammals, beginning with seven maps about polar bears. Four half-page maps deal effectively with the intersection of the bears' seasonal marine habitat selection (in light-to-dark green tones) with the outlines of their three annual subpopulation core areas, and their ranges for hunting and denning.

Pinnipeds are next, opening with two large Summer/Fall and Winter/Spring seasonal maps on the Pacific walrus. The first depicts areas of regular use, concentration, and high concentration overlaid by four classes of graduated circles of current (2000—present) and historic (1850s—1990s) haul-outs (places they haul themselves out of the water), while the second shows only areas of use. The color scheme for areas of use changes from pale yellow-to-brown to light-to-dark purple between the two maps.

Bearded, ribbon, ringed, spotted, and northern fur seals each earn a half-page map, but the Steller sea lion merits a two-page map illustrating adult female foraging ranges, seasonal migration, critical habitats, and three classes of graduated diamonds for rookery populations.

Cetaceans finish off this chapter, beginning with two maps of the beluga whale counts, ranges, and migration. Curiously, the larger of the two includes an independent beluga population in Cook Inlet, which is outside the atlas study area. Bowhead whales are given four half-page maps, and gray whales a single half-page map. The humpback whale map is supplemented by a world map from NOAA showing humpback distinct population segment (DPS) groups with their respective breeding/wintering grounds and northern feeding areas, and indicating their population status as endangered, threatened, or "not at risk." It is not clear why world humpback populations, including southern hemisphere stocks, are shown, but not their Antarctic and sub-Antarctic feeding grounds.

The seventh chapter centers on human use of the areas in and around the three seas. Power plant locations and capacities, roads, sub-sea cable routes, airports, and ferry routes all feature. On the Transportation and Energy Infrastructure map, which uses graduated circles for power plants and points for airports, what looks like significant infrastructure exists around Kodiak Island, but the symbols are largely obscured as the map data gradually fades off. This is very much like the faded map data on the Marine Bird Colonies map, and raises the question of why these data are included at all. Either Kodiak Island is outside the study area, and should be excluded, or Kodiak's infrastructure is important contextual information and should be included: giving faded data sets is just a tease.

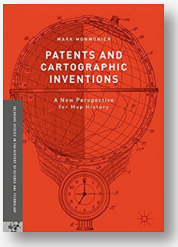
A simple and informative one-third page map of oil and gas infrastructure (roads, pipelines, gravel pads, and gravel islands) of the Alaskan northern shore is followed by a large map of the three seas showing petroleum exploration and development—depicting active and expired leases, planning areas, areas with petroleum potential, and current offshore and onshore wells. Factors concerned with vessel traffic are introduced with a small map helpfully showing the locations of emergency resources: Coast Guard bases, spill response equipment, and towing capacity. Two, colorful, two-page maps that deal with vessel traffic density and movement patterns differentiated by tanker, cargo, towing/tug, and fishing vessels in the three seas and the northern Gulf of Alaska present a spatial picture of a very busy maritime area. Also included are locations for shipwrecks and Coast Guard facilities, as well as the route of the first passenger cruise ship that traversed the Northwest Passage in 2016, the *Crystal Serenity*. Twelve small, monthly maps of vessel traffic are accompanied by a half-page total traffic density map. This last map duplicates one that appeared four pages earlier, with the addition of Areas to be Avoided—a topic that was discussed four pages earlier as well. The overview of vessel traffic is wrapped up with a closer look at the situation in and around Unimak Pass and the Bering Strait, described with bar graphs and a small map of each area.

The map of Fisheries Management Conservation Areas requires a bit of study, since this one map of all three seas covers areas of trawling restrictions, commercial fishing restrictions, prohibitions on bottom contact gear, and Steller sea lion protected areas, along with commercial fishing ports, the Alaskan state water boundary, and the average annual observed catch (in metric tons) in the central and eastern Bering Sea. Seven half-page maps cover the subsistence harvest of six major types of maritime produce—birds and eggs, fishes, marine invertebrates, polar bears, seals, walruses, and whales—followed by a two-page map of total subsistence harvest for six coastal Alaskan areas. The sheer amount of data on this last map required presenting it as regional graphs with one dot equaling ten pounds per capita of annual subsistence harvest of each produce type. The last map of this chapter covers conservation areas, classed by status as strict nature reserves, wilderness areas, national parks, national wildlife refuges, and protected areas with sustainable use of natural resources. It also includes nearby protected areas outside the Arctic boundary.

The atlas finishes with a conservation summary that includes discussions of climate change and other pressure points, and specifically addresses nine conservation themes and their management implications. Within each chapter, map data sources are given for all of the maps produced by Huffman, and a mapping methods subsection is provided to describe the rationale for all of the indexed major maps. Each section of every chapter has separate authors and independent reviewers. Legends and photos are effectively integrated into the maps with background base map data that fades away underneath. Moreover, each chapter has its own reference section; typically quite extensive.

While I have noted some quibbles in this review, they are all really quite minor complaints. Audubon Alaska, and especially Daniel Huffman, have achieved the goals laid out in the Introduction, and they can all be proud of this beautiful atlas.

PATENTS AND CARTOGRAPHIC INVENTIONS: A NEW PERSPECTIVE FOR MAP HISTORY



By Mark Monmonier

Palgrave Macmillan, 2017

267 pages, $109.99, hardcover.

ISBN: 978-3-319-51039-2

Review by: John J. Swab, University of Kentucky

Mark Monmonier makes a significant contribution to the contextualization of recent cartographic history with his new book *Patents and Cartographic Inventions*: *A New Perspective for Map History*. Focused on cartographic innovations approved for patents by the United States Patent and Trademark Office, the book weaves together the fascinating stories of the individuals who developed new mapping technologies from the mid-nineteenth century to the pre-digital twentieth century. Monmonier sees cartographic patents as a little-explored, "parallel literature" to academic cartographic scholarship (6). He proposes that the patent system, with a similar peer-review-like process conducted by patent examiners, provides both a methodological and metaphorical lens through which to understand cartographic innovations over the past century and a half.

The book is organized around thematic chapters examining innovations in identifying locations, wayfinding systems, map folding systems, map projections, novel globes, and a variety of other pre-digital cartographic topics. It examines how the inventions in each of these subthemes built upon both real-world challenges and previously submitted patents, while also detailing the larger stories behind the individual inventors and their adventures navigating the patent application process. As Monmonier's research uncovers, many of these patented innovations were useful and innovative technological developments, even if most were commercially unsuccessful.

While it may be common to believe that georeferencing technologies were only developed recently, as part of the geospatial revolution, an examination of patent records finds antecedents throughout the early twentieth century. For example, multiple patents addressed wayfinding systems that provided nuanced geographic information to aid travelers to reach their destination. Rolled strip maps, advanced by the revolution of car wheels or by hand, were among the first GPS-like technologies. Rural homestead finding systems, developed and sold from the 1910s to the 1930s, provided specially designed maps to aid visitors in locating specific farmsteads down poorly marked country roads.

Other types of inventions, such as those related to map projections or folding systems, were often far less commercially successful. Here, Monmonier contends, it was often more effective to simply use copyright law than to struggle through the patent application process. The important role played by patented paper folding machines (in developing novel ways to fold maps) is touched upon as an example of how innovations in other technologies can lead to new patentable inventions in the cartographic realm. Patent applications for new globes often stressed their educational qualities, with patents filed to protect innovations in mechanical globes highlighting atmospheric phenomena or orbital patterns. With the vast majority of patent applications filed by men, it is notable how the gendered nature of education played out with a relatively large number of globe patents issued to female inventors.

As the book recounts in example after example, winning approval from the United States Patent Office was (and still is) an arduous, time-consuming affair. Applications often languished for years, as examiners, inventors, and lawyers haggled over the meaning of descriptions, redrew poorly executed drawings, and bickered over sweeping technical claims. In practice, this often meant that applications took long periods of time, involving multiple rounds of revisions before finally receiving approval. Occasional grandstanding on the part of the inventor, the patent lawyer, and/or the patent examiner often led to ultimatums, fraught responses, and desperate appeals for leniency.