Introduction
GIS for Science: A Framework and a Process—Jack Dangermond and Dawn J. Wright, Esri
Introduction by the Editors—Dawn J. Wright and Christian Harder, Esri
Foreword—Edward O. Wilson

Part 1: How Earth Works
Earth’s Coastlines—Roger Sayre, Madeline Martin, and Jill Cress, U.S. Geological Survey; Kevin Butler, Keith Van Graafeiland, Sean Breyer, Dawn Wright, Charlie Frye, Deniz Karagulle, Esri; Tom Allen, Old Dominion University; Rebecca J. Allee, Rost Parsons, National Oceanic and Atmospheric Administration; Bjorn Nyberg, University of Bergen, Norway; Mark J. Costello, Nord University, Norway; Frank Muller-Karger, University of South Florida; and Peter Harris, GRID-Arendal, Norway
With approximately half the world’s population living less than 65 miles from the ocean, coastal ecosystems are arguably Earth’s most critical real estate. Yet coastlines are among the more difficult features to accurately map; until now, no comprehensive high-resolution geospatial dataset existed. This chapter presents a new map and ecological inventory of global coastlines developed by Esri, the U.S. Geological Survey, and other partners.

Preventing Species Extinctions—Healy Hamilton and Regan Smyth, NatureServe
Our natural world is under increasing threat from incompatible land use, pollution, and climate change. Scientists at NatureServe are using advanced GIS modeling approaches to map suitable habitat for imperiled species at high resolution, giving decision-makers the information they need to reduce conflicts between wildlife and humans and conservation measures.

Mapping Half-Earth—D. Scott Rinnan, Yale University; Greta C. Vega, Estefanía Casal, Camellia Williams, Vizzuality; and Joel Johnson and Chris Helme, E.O. Wilson Biodiversity Foundation
Spatial biodiversity knowledge is vital for effective conservation planning. The Half-Earth Project creates a comprehensive map of our planet’s biodiversity to inform and track conservation efforts and ensure that no species is driven to extinction from lack of knowledge.

Part 2: How Earth Looks
From Plots to Pixels—Christopher Oswalt, Charles “Hobie” Perry, David Bell, Charles E. Werstak Jr., James Garner, and Barry “Ty” Wilson, U.S. Forest Service
Forest Inventory and Analysis (FIA), a U.S. Forest Service program since 1930, collects data on more than 355,000 forest plots on public and private lands. FIA’s latest data, deployed in the cloud with sophisticated GIS analysis tools, remains a mission-critical planning tool for the agency.

Blueprint for a Better Future—Maryam Rabiee, United Nations Sustainable Development Solutions Network, and Ismini Ethridge, Columbia University
The nearly 200 member states of the United Nations aim to end poverty, protect the planet, and promote peaceful and inclusive societies by 2030. This chapter introduces the framework for these aspirational goals and examines how GIS is helping to move them forward.

Conserving the Last Ocean Frontiers—Daniel Wagner and T. ‘Aulani Wilhelm, Conservation International, Center for Oceans; Alan M. Friedlander, National Geographic Society, University of Hawai‘i; Richard L. Pyle, Bernice P. Bishop Museum; Kristina M. Gjerde, International Union for the Conservation for Nature; Erin E. Easton, University of Texas, Rio Grande Valley; Carlos F. Gaymer and Javier Sellenas, Universidad Catolica del Norte, Chile; Cassandra M. Brooks, University of Colorado, Boulder; Liesbeth van der Meer, Oceana Chile, Santiago; and Lance E. Morgan and Samuel E. Georgian, Marine Conservation Institute
The unique combination of natural and cultural resources has made the Salas y Gómez and Nazca Ridges a top priority for protection on the high seas. With support from global datasets and GIS analysis, researchers have identified this area off the west coast of South America as a key location to conserve and protect marine biodiversity without impacting industries.
Part 3: How We Look at Earth

AI for Geospatial Analysis—Bonnie Lei, Microsoft; Kate Longley-Wood and Zach Ferdana, The Nature Conservancy; Susanna De Beauville-Scott, Organisation of Eastern Caribbean States; and Julian Engel, OceanMind

Marine and Earth scientists are using treasure troves of emerging geospatial data to apply artificial intelligence to their work as never before. Pervasive cloud computing and rapidly improving machine and deep learning algorithm capabilities have combined to create a new GIS neural network.

Mapping Extreme Events from Space—NASA Earth Science Division

Observations from land, ships, balloons, aircraft, satellites, and the International Space Station all help NASA understand the planet’s atmosphere, land cover, ice fields, and oceans. These datasets, collected from even the most remote areas of Earth, are freely and openly available to anyone.

The Science of Ocean Acoustics—Chris Verlinden, Sarah Rosenthal, Jennifer Brandon, Kevin Heaney, and James Murray, Applied Ocean Sciences

Understanding the soundscape of the world involves using an array of global tracking data, acoustic propagation models, and GIS. Together, these data and technologies help scientists identify Earth's loud and quiet places and learn about the implications of those results.

Part 4: Training Future Generations of Scientists

Spatial Thinking Effects on the Human Brain—Bob Kolvoord, James Madison University

The Geospatial Semester (GSS) partners Virginia high schools with the School of Integrated Science at James Madison University. In addition to launching hundreds of students into academic careers in GIS and geographic sciences, GSS uniquely measures the effects of geospatial thinking on brain function. Its work provides compelling evidence that a spatial approach to science, technology, engineering, and math effectively teaches students crucial skills to succeed in college and beyond.

Fueling Curiosity to Foster a Healthy Planet—Vicki Phillips, National Geographic Society

Geography opens the door for learners to better understand the interconnected world. It gives young people the insight to draw connections, measure how individual actions can change the world, assess costs and benefits, and seek solutions to the many complex questions about our planet. Operating at the intersection of exploration, documentation, and mapping, young National Geographic Explorers are positioning themselves to confront the future's looming problems.

Teaching Spatial Data Science and Deep Learning—Ilya Zaslavsky, UCSD; and Dmitry Kudinov, Esri

Fueled by massive GIS data repositories, deep learning and neural networks enable data scientists to apply machine learning techniques to a growing range of real-world problems. Education leaders at the University of California, San Diego, are training a new generation of geo-literate scientists. This chapter explores the short history of deep neural networks, describes the teaching approach at UCSD, and examines several practical applications at the intersection of GIS and AI.

Part 5: Technology Showcase

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