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Letter of Introduction to the Biologically Important Areas Issue

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This special issue on Biologically Important Areas (BIAs) has been a long time in the making. It has taken considerable effort from all of the authors involved, in addition to a large body of diverse reviewers, to produce these papers. This issue originated as a side bar to the Cetacean Density and Distribution Mapping (CetMap) Working Group, a part of the National Oceanic and Atmospheric Administration's (NOAA) CetSound program (http://cetsound.noaa.gov). The CetMap Working Group created a mapping tool that provides cetacean density and distribution maps that are time-, region-, and species-specific. Additionally, our CetMap tool highlights areas, seasons, and species for which there are clear data gaps.

The CetMap Working Group recognized the necessity of creating BIAs to incorporate additional information into the mapping tool by identifying areas where cetacean species or populations are known to concentrate for specific behaviors, or are range-limited, but for which there are insufficient data for their importance to be reflected in the quantitative mapping effort. The result of the BIA assessment process includes narratives, maps, and tables that provide additional context within which to examine potential interactions between cetaceans and human activities. Our aim for this assessment is to combine expert judgment with available data (published or unpublished) to delineate BIAs for each species and each region. Our goal is not to define marine protected areas. Rather, we are identifying sites where cetaceans engage in activities at certain times that contribute to an individual's health and fitness and, ultimately, to the fecundity and survivorship of the population. During the conservation and management decision-making process, BIAs should be considered in addition to existing density estimates, range-wide distribution data, information on population trends and life history parameters, known threats to the population, and other relevant information.

The review process for these BIA chapters was extensive and thorough. Dr. Kathleen Dudzinski served as the main editor and I as guest editor for this issue. Prior to submission, each chapter was reviewed by between 12 to 30 regional experts from within and outside NOAA (both scientists and managers), including some of the CetMap Working Group members. Upon submission to *Aquatic Mammals*, Dr. Dudzinski reviewed all manuscripts with an eye to promoting consistency and accuracy across all the BIAs, in addition to soliciting reviews from two to three external reviewers for each chapter through the journal's review process.

There are eight chapters in this special issue, an introduction and seven regional manuscripts covering the U.S. East Coast, Gulf of Mexico, U.S. West Coast, Hawai'i, Gulf of Alaska, Aleutian Islands and Bering Sea, and the Arctic. There are a total of 131 BIAs covering 24 species. Each chapter was written by scientific experts who have a thorough knowledge of the species and region in question. Although a common theme unites all chapters, there are regional variations in the amount and type of information available to undertake the assessment and the number and types of species covered. It was not feasible to create BIAs for every species due to either the lack of information to support the delineation or, in some cases, simply due to the time available for this effort. However, these BIAs are meant to be living documents that should be routinely reviewed and revised to expand the number of species covered and to update the existing BIAs as new information becomes available.

In that light, it is critical to start this special issue where all good things should start, at the beginning. The BIA special issue begins with an introductory chapter that highlights the rationale and decisions made during this inaugural BIA assessment process. This is a MUST read before you delve further into a regional chapter. The "Overview and Rationale" includes all the BIA criteria and caveats and summarizes these in a digestible series of tables. We hope that this BIA special issue will be of use to scientists and managers alike and will assist with planning, analyses, and decisions regarding how to reduce adverse impacts to cetaceans resulting from human activities.

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1. Biologically Important Areas for Cetaceans Within U.S. Waters – Overview and Rationale

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Abstract

We outline the rationale and process used by the Cetacean Density and Distribution Mapping (CetMap) Working Group to identify Biologically Important Areas (BIAs) for 24 cetacean species, stocks, or populations in seven regions within U.S. waters. BIAs are reproductive areas, feeding areas, migratory corridors, and areas in which small and resident populations are concentrated. BIAs are region-, species-, and time-specific. Information provided for each BIA includes the following: (1) a written narrative describing the information, assumptions, and logic used to delineate the BIA; (2) a map of the BIA; (3) a list of references used in the assessment; and (4) a metadata table that concisely details the type and quantity of information used to define a BIA, providing transparency in how BIAs were designated in a quick reference table format. BIAs were identified through an expert elicitation process. The delineation of BIAs does not have direct or immediate regulatory consequences. Rather, the BIA assessment is intended to provide the best available science to help inform regulatory and management decisions under existing authorities about some, though not all, important cetacean areas in order to minimize the impacts of anthropogenic activities on cetaceans and to achieve conservation and protection goals. In addition, the BIAs and associated information may be used to identify information gaps and prioritize future research and modeling efforts to better understand cetaceans, their habitat, and ecosystems.

Key Words: anthropogenic activity, anthropogenic sound, CetMap, BIA, distribution, behavior, conservation, management, Arctic, Aleutian Islands, Bering Sea, North Pacific Ocean, Gulf of Alaska, Washington, Oregon, California, Hawaiian Islands, Gulf of Mexico, Northwest Atlantic Ocean

Introduction

Anthropogenic activities in the marine environment are increasing in number, geographic extent, and often duration, resulting in increased potential risk to marine ecosystems worldwide (Hooker & Gerber, 2004; Convention on Biological Diversity [CBD], 2009; Reeves et al., 2013). Activities of concern for the conservation and management of marine species are diverse and include energy development (e.g., wind farm installation; oil and gas exploration, development, and production), military testing and training (e.g., sonar exercises and equipment prototyping), shipping, fishing, tourism, and coastal construction, among others. This special issue focuses on the potential effects of human activities on cetaceans. Several components of the activities mentioned above have the potential to adversely affect cetaceans, including the possibility of vessel strike; bycatch or entanglement; alteration of habitat through physical changes, chemical pollution, or introduction of alien invasive species; and indirect effects related to prey distribution and abundance. However, one common component of these activities is underwater noise, which is present to some degree in almost every marine activity and can affect large areas over long periods of time.

Sound is critical to cetaceans for communicating, detecting predators and prey, navigating, and sensing other important environmental cues. A *soundscape* is comprised of all of the sounds in a place, including geophysical, biological, and manmade contributions. When examined from the perspective of the animals experiencing and using it, a soundscape may also be referred to as an "acoustic habitat" (Clark et al., 2009, p. 203). Increased anthropogenic sound from single or multiple sources can have deleterious effects on cetaceans' acoustic habitats, reducing their ability to detect

critical sounds, often across large areas and long periods of time. In addition to these more chronic acoustic habitat impacts, anthropogenic noise can cause direct, or acute, effects ranging from altering important behaviors and threshold shifts in hearing, to injury, or even death, in certain circumstances. The probability, nature, and extent of an animal's response to sound depends on a variety of contextual factors, including the activity or behavior in which the animal is engaged at the time of sound exposure (e.g., feeding, breeding, resting, migrating, nursing), the nature and novelty of the sound, and the location of the sound source relative to the animal (Ellison et al., 2012). However, both chronic and acute effects of noise have the potential to negatively affect an individual's health and fitness in certain circumstances, ultimately leading to effects on a population's fecundity or survivorship.

Following on the earlier work of a U.S. National Research Council (NRC) (2005) committee, New et al. (2014), in an effort termed the *Potential Consequences of Disturbance*, outlined an updated conceptual model of the relationships linking disturbance to changes in behavior, physiology, health, vital rates, and population dynamics. Further, New et al. created an energetic model for southern elephant seals (*Mirounga leonina*) to study links between disturbance and population-level effects. Based on extensive morphological, environmental, and tag data, and biological samples, the model predicts the quantitative transfer functions (i.e., mathematical relationships) among reduced foraging success (potentially the result of context-specific disturbance events), adult mass, pup wean mass, and pup survival. It is clear that understanding the behaviors and activities animals are involved in when exposed to stressors may affect both their immediate response and the ultimate effect of that response. Ellison et al. (2012) suggested that federal agencies responsible for regulating entities producing sound with the potential to affect marine mammals should incorporate behavioral context where possible into their impact assessments.

In the United States, the National Oceanic and Atmospheric Administration (NOAA) is charged with implementing multiple federal statutes, including the Marine Mammal Protection Act (MMPA) (16 USC § 1361 et seq.), the Endangered Species Act (ESA) (16 USC § 1531 et seq.), and the National Marine Sanctuaries Act (NMSA) (16 U.S.C. § 1431 et seq.), which contain provisions for the protection and conservation of marine mammals. These statutes all have sections that address federal or public activities with the potential for disturbing or harming marine mammals, their populations, or their habitat, and in many cases necessitate a consultation or coordination between NOAA and the entity planning to conduct the activity. Additionally, the entities seeking approvals from NOAA pursuant to these statutes are required to provide information and impact analyses with their requests. Separately, the National Environmental Policy Act (NEPA) (42 USC § 4321 et seq.) requires all federal agencies to analyze the potential impacts of their activities on the environment, including marine mammals, and to consider enacting mitigation measures.

NOAA must ultimately reach conclusions, specific to each statute, regarding the scope and significance of the anticipated impacts of a proposed activity to the affected individuals and their habitat, and how the effects to individual marine mammals may impact populations. The analyses inform the development and requirement of appropriate mitigation and monitoring measures. The conclusions can affect whether the entities conducting the activities can proceed with their activities as planned or need to modify their activities. These processes typically culminate in the issuance or denial of an authorization, permit, exemption, or recommendation letter from NOAA or other agencies with jurisdiction over specific activities. As noted above, the ability to characterize cetacean behaviors or activities in given areas or times is important in the assessment of likely impacts of a proposed activity and the development of appropriate mitigation strategies. Furthermore, this ability would be valuable to both regulators and regulated entities.

The focus of this issue largely relates to understanding activities in which cetaceans, in particular, are likely to be engaged at a certain time and place, which is indicative of an area's biological importance for purposes of impact analysis and management. The idea for this undertaking was conceived in 2011 when NOAA convened the Cetacean Density and Distribution Mapping (CetMap) Working Group (http://cetsound.noaa.gov) to map cetacean density and distribution within U.S. waters. CetMap members were affiliated with government agencies, nongovernmental organizations, academic institutions, and private research or environmental consulting firms. CetMap members brought a diversity of experience in cetacean ecology, conservation, and management to the project, ranging from policy to modeling to field work. The primary goal of CetMap was to create and compile comprehensive and easily accessible regional cetacean density and distribution maps that are time- and species-specific, ideally using survey data and models that estimate density using predictive environmental factors. CetMap considered predictive habitat-based density (HD) models to be the best tool for addressing spatially and temporally explicit questions on cetacean abundance,

density, or distribution; however, HD models require a considerable amount of relatively high-quality data, which is available for only a limited number of species, regions, and time periods (Kot et al., 2010; Kaschner et al., 2012). Furthermore, HD models typically do not provide direct information on activity state, nor do they provide information on animal distribution at the relevant time and space scales that can be obtained from primary information sources such as acoustic, sighting, genetic, and tagging data and expert knowledge. Therefore, it is important to supplement areas that might be identified through HD models with additional information.

To augment CetMap's quantitative density and distribution mapping effort and to provide additional context for cetacean impact analyses, CetMap undertook a process to identify, through expert consultation, Biologically Important Areas (BIAs). BIAs are reproductive areas, feeding areas, migratory corridors, and areas in which small and resident populations are concentrated. Similar to other products on the CetMap website, the cetacean BIAs are region-, species-, and time-specific. Although all products on the CetMap website are restricted to cetaceans, the tools could be extended to include other marine mammals such as pinnipeds (seals, sea lions, fur seals, and walruses), sirenians (manatees and dugongs), and fissipeds (sea otters and polar bears).

BIAs were created to aid NOAA, other federal agencies, and the public in the analyses and planning that are required under multiple U.S. statutes to characterize and minimize the impacts of anthropogenic activities on cetaceans and to achieve conservation and protection goals. In addition, the BIAs and associated information may be used to identify information gaps and prioritize future research and modeling efforts to better understand cetaceans, their habitat, and ecosystems. Because this is a scientific effort, the identification of BIAs does not have direct or immediate regulatory consequences. Rather, the BIA assessment is intended to provide the best available science to help inform regulatory and management decisions under existing authorities about some, though not all, important cetacean areas. For decision-making purposes, the BIAs identified here should be evaluated in combination with areas identified as having high cetacean density; the present effort is meant to augment, not displace, cetacean density analyses.

Herein, we describe the process that CetMap implemented to delineate BIAs; summarize the resulting BIAs; discuss strengths and limitations of the existing BIAs and assessment process; and suggest ways in which this BIA assessment can be improved in the future. Furthermore, we compare CetMap's BIA assessment to similar international assessments such as the International Union for Conservation of Nature's (IUCN) Key Biodiversity Areas (KBAs) and Important Marine Mammal Areas (IMMAs), Convention on Biological Diversity's Ecologically or Biologically Significant Areas (EBSAs), Pacific WildLife Foundation's (PWLF) Important Cetacean Areas (ICAs), and Australia's Biologically Important Areas.

The final products of CetMap's BIA assessment comprise the subsequent articles in this special issue that are presented as seven chapters, separated based on regional divisions that reflect Large Marine Ecosystem delineations (Sherman & Alexander, 1986) (Figure 1.1). These regions are comprised of the U.S. East Coast, Gulf of Mexico, West Coast, Hawai'i, Gulf of Alaska, Aleutian Islands and Bering Sea, and the Arctic (encompassing the northeastern Chukchi and western Beaufort Seas). The abbreviations used in this special issue are defined in Table 1.1.

Methods

The CetMap BIA assessment is a species-focused, science-based process that is restricted to U.S. waters. Areas are delineated based on their importance to specific species, stocks, or populations. (Hereafter, "species" will be used to represent species, stocks, and populations, unless a subspecific unit is essential for interpretation.) This inaugural BIA assessment is not comprehensive in the species evaluated. Rather, it incorporates a large number of species representing a range of habitats, foraging methods, social structures, movement patterns, life history strategies, and population sizes. This strategy of completing a trial assessment with a limited suite of representative species is similar to some of the international assessments described below. The best available science is used to evaluate candidate species and areas according to the BIA criteria listed below. The assessment is free from legal, socioeconomic, and political constraints, with the exception that it is limited to U.S. waters for practical purposes. Any use of these BIAs in regulatory decisions will be subject to the standard processes of analysis and review under the applicable statutes. CetMap defines "U.S. waters" as the region shoreward of the offshore boundary of the U.S. Exclusive Economic Zone (EEZ); therefore, U.S. waters under this definition include state waters.

CetMap BIA Criteria

The BIA criteria are guidelines for delineating areas of biological importance for cetaceans. The criteria allow the flexibility to assess ecologically diverse species using the information available, which spans a wide range in quality, quantity,

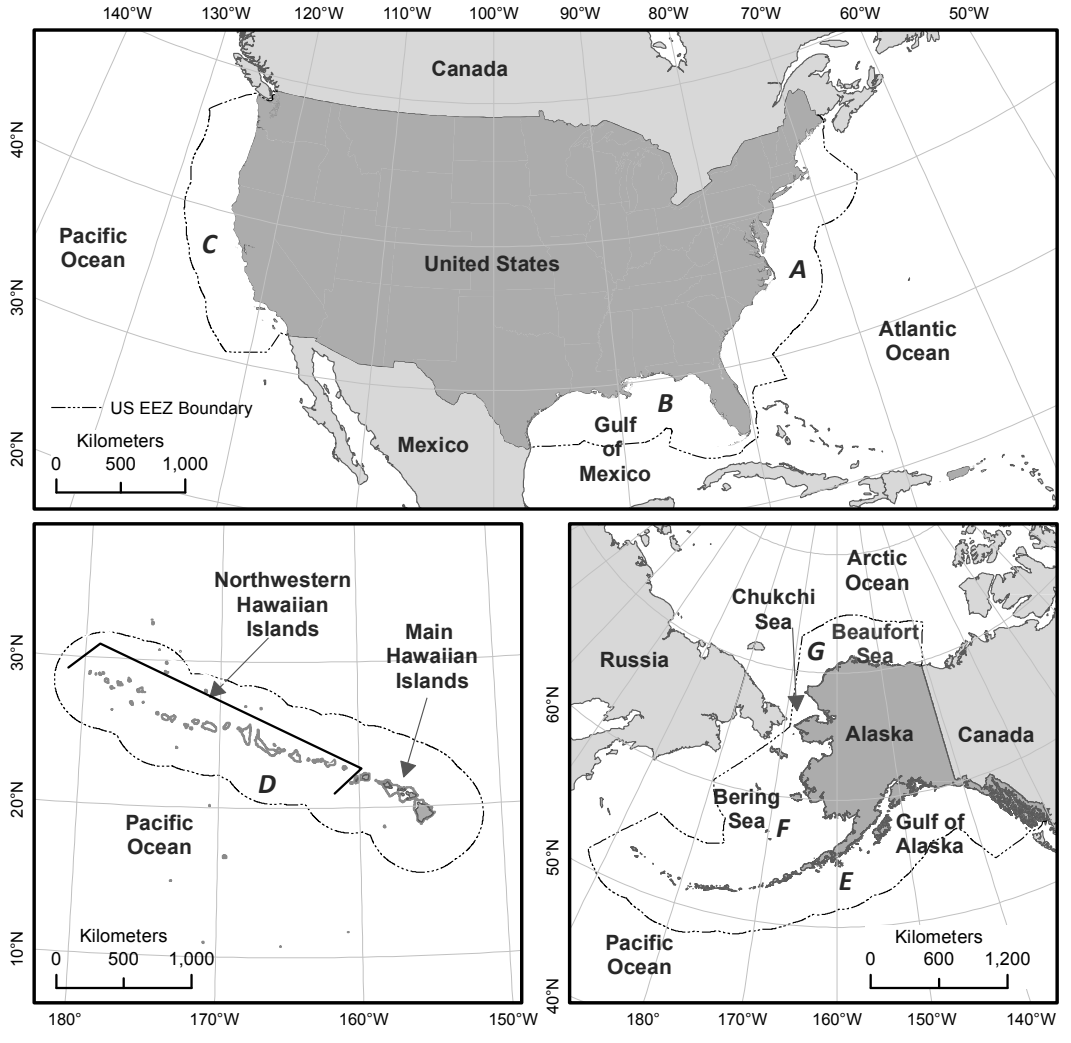

Figure 1.1. Overview of study area, showing the seven regions within which Biologically Important Areas (BIAs) were assessed. All BIAs were delineated solely within the U.S. waters, which we define as the region shoreward of the offshore boundary of the U.S. Exclusive Economic Zone (EEZ), including state waters. The seven regions are labeled clockwise starting in the east: A. East Coast (Chapter 2 in this issue); B. Gulf of Mexico (Chapter 3 in this issue); C. West Coast (Chapter 4 in this issue); D. Hawai'i (Chapter 5 in this issue); E. Gulf of Alaska (Chapter 6 in this issue); F. Aleutian Islands and Bering Sea (Chapter 7 in this issue); and G. Arctic (Chapter 8 in this issue).

and type. The criteria are not based on thresholds. CetMap considers an area to be biologically important for cetacean species, stocks, or populations (denoted by "species" in the criteria) if it meets at least one of the following four criteria (see also Table 1.2):

1. *Reproductive Areas* – Areas and times within which a particular species selectively mates, gives birth, or is found with neonates or calves
2. *Feeding Areas* – Areas and times within which aggregations of a particular species preferentially feed. These either may be persistent in space and time or associated with ephemeral features that are less predictable but are located within a larger area that can be delineated.
3. *Migratory Corridors* – Areas and times within which a substantial portion of a species is known to migrate; the corridor is spatially restricted.
4. *Small and Resident Population* – Areas and times within which small and resident populations occupy a limited geographic extent

Table 1.1. Abbreviations used in this special issue; the state abbreviations are used in many of the figures.

Abbreviations				U.S. state abbreviations	
ASAMM	Aerial Surveys of Arctic Marine Mammals	IUCN	International Union for Conservation of Nature	AK	Alaska
BCB	Bering-Chukchi-Beaufort	IWC	International Whaling Commission	AL	Alabama
BIA	Biologically Important Area	IWC-POWER	IWC-Pacific Ocean Whale and Ecosystem Research	CA	California
BOEM	Bureau of Ocean Energy Management	KBA	Key Biodiversity Areas	CT	Connecticut
BOWFEST	Bowhead Whale Feeding Ecology Study	m	Meter(s)	DC	Washington, DC
BS	Beaufort Stock	MMPA	Marine Mammal Protection Act	DE	Delaware
BSE	Bays, Sounds, Estuaries	MMS	Minerals Management Service	FL	Florida
CalCOFI	California Cooperative Oceanic Fisheries Investigations	mtDNA	Mitochondrial DNA	GA	Georgia
CBD	Convention on Biological Diversity	NEFSC	Northeast Fisheries Science Center	HI	Hawai‘i
CeTAP	Cetacean and Turtle Assessment Program	NEPA	National Environmental Policy Act	LA	Louisiana
CIB	Cook Inlet Belugas	NMFS	National Marine Fisheries Service	MA	Massachusetts
CRC	Cascadia Research Collective	nmi	Nautical mile(s)	MD	Maryland
CV	Coefficient of Variation	NMML	National Marine Mammal Laboratory	ME	Maine
DNA	Deoxyribonucleic acid	NMSA	National Marine Sanctuaries Act	MS	Mississippi
DPS	Distinct Population Segment	NNCES	Northern North Carolina Estuarine System	NC	North Carolina
EBSA	Ecologically or Biologically Significant Area	NOAA	National Oceanic and Atmospheric Administration	NH	New Hampshire
ECS	Eastern Chuckchi Sea	PCCS	Provincetown Center for Coastal Studies	NJ	New Jersey
EEZ	Exclusive Economic Zone	PCFG	Pacific Coast Feeding Group	NY	New York
EIS	Environmental Impact Statement	PRIEST	Pacific RIght whale Ecology STudy	OR	Oregon
ENP	Eastern North Pacific	PWLF	Pacific WildLife Foundation	RI	Rhode Island
ESA	Endangered Species Act	SAR	Stock Assessment Report	SC	South Carolina
FR	*Federal Register*	SNACS	Study of Northern Alaska Coastal System	TX	Texas
GMI	Geo-Marine, Inc.	SNCES	Southern North Carolina Estuarine System	VA	Virginia
GOALS	Gulf of Alaska Line-transect Survey	SOSUS	SOund SUrveillance System	WA	Washington
HD	Habitat-based density	SPLASH	Structure of Populations, Levels of Abundance and Status of Humpbacks		
ICA	Important Cetacean Areas	UAF GAP	University of Alaska Fairbanks Gulf Apex Predator-Prey Project		
IMMA	Important Marine Mammal Areas	WNP	Western North Pacific		

Table 1.2. The criteria defined below are guidelines for delineating Biologically Important Areas (BIAs) in U.S. waters for cetaceans. The criteria are not based on quantitative thresholds. CetMap considers an area to be biologically important for a cetacean species, stock, or population (denoted by "species" in the criteria) if it meets at least one of these four criteria.

Criteria	Definition	Map color[1]
Reproductive Area	Areas and times within which a particular species selectively mates, gives birth, or is found with neonates or calves	
Feeding Area	Areas and times within which aggregations of a particular species preferentially feed. These either may be persistent in space and time or associated with ephemeral features that are less predictable but are located within a larger area that can be delineated.	
Migratory Corridor	Areas and times within which a substantial portion of a species is known to migrate; the corridor is spatially restricted.	
Small and Resident Population	Areas and times within which small and resident populations occupy a limited geographic extent	

[1] In figures where there is more than one BIA of the same type, or where multiple BIAs are included and overlapping, the same color scheme is used with horizontal or vertical lines. All depths shown are in meters, unless otherwise noted. The U.S. Exclusive Economic Zone (EEZ) is represented as a dashed line (— · · — · ·) in maps where it is visible.

Certain qualifying statements are included in the BIA criteria. For example, the migratory corridor criterion designates a "substantial portion of a species" that migrates in a "spatially restricted" area. Within the context of informing conservation and management decisions, it is less useful to know that a small portion of a species might regularly use a 1,000-km swath of the Pacific Ocean to travel from California to Hawai'i than it is to know that 100% of a species migrates through the waters of the Bering Strait (~80 km wide) twice each year. Additionally, CetMap restricts the fourth type of BIA to "small and resident" populations "that occupy a limited geographic extent" because NOAA's *Marine Mammal Stock Assessment Reports* already cite the range and abundance of all recognized U.S. marine mammal species or populations, including small or resident populations whose range is either unknown or relatively large. The North Pacific right whale is an example of a small population that did not qualify for a small and resident BIA because their range is relatively large. The Gulf of Mexico resident sperm whale is an example of a resident population whose overall spatial extent was too large to be defined as a BIA. While CetMap does not explicitly define "small" and "limited geographic extent," we delineate BIAs for populations or stocks whose range spans only a bay, an area around one or several islands, or a portion of what CetMap defines as a region. Each regional chapter provides an explicit definition of "resident" for each small and resident BIA delineated.

Areas that NOAA has officially designated as Critical Habitat are included as BIAs, either in part or whole, only if they meet at least one of the BIA criteria stated above. The development of Critical Habitat considers a complex combination of factors that do not always match the simple definition of BIAs; therefore, not everything identified as Critical Habitat will meet the BIA criteria and vice versa. Where BIAs have been designated in regions for species that have Critical Habitat, the Critical Habitat is identified, and its relationship to the BIA is described (i.e., completely, partially, or not overlapping) and mapped.

BIAs are delineated at the minimum spatial and temporal scales that available information can support. Coastal BIA assessments were conducted using *GSHHS*, Version 2.2.4 (full resolution, level L1) (Wessel & Smith, 1996). Most BIAs were defined by month, but some could only be identified by a particular season, which was typically a 3- to 4-mo period. For each region, species, and time period with delineated areas of biological importance, four products were created and compiled into the regional chapters in this issue: (1) a written narrative describing the information, assumptions, and logic used to delineate the BIA; (2) a map of the BIA; (3) a list of references used in the assessment (see the "Literature Cited" section at the end of the issue); and (4) a metadata table (see online supplemental tables associated with each region). The metadata table concisely details the type and quantity of information used to define a BIA, providing transparency in how BIAs were designated in a quick reference table format. In addition, the metadata table allows an efficient way to update a BIA as new information becomes available.

Early in the BIA assessment process, CetMap considered defining a ranked categorical scale for BIAs based on the strength of supporting information. One obstacle to creating a single ordinal categorization scheme is that the collection of

all potential applications for BIAs is broad, and a single scheme is unlikely to weight each contributing factor appropriately for all scenarios. Additionally, due to limited understanding of the linkages between individual- and population-level effects, CetMap did not rank the BIAs based on relative importance inferred from known or assumed impacts associated with disruption of specific behaviors or other threats to the species. The Working Group concluded that information would be lost in a simple ranking process, and that it is better to document the assumptions and reasoning in each BIA narrative, and to compile the relevant detailed information in associated metadata tables and the list of references.

Expert Elicitation and Review Processes

The data that can be used to characterize BIAs varies considerably in availability, quality, quantity, and type (i.e., sampling methodology used to collect it); therefore, expert interpretation and integration of existing information, based on broad and detailed knowledge of regions, species, and the assumptions associated with different datasets, is needed to characterize these areas. The elicitation process was designed based on an expert panel approach to foster pooling of knowledge. CetMap defined a regional expert as an individual or research group that was actively conducting scientific research (field work and analyses) in the region, was internationally recognized, and had a large body of peer-reviewed publications on the species in question and/or the region. The experts were affiliated with a range of institutions, including academic institutions, governmental agencies, and nongovernmental organizations, including a nonprofit research consortium. The amount of experience in cetacean ecology that each expert who led the drafting of the BIAs brought to the panel ranged from one to over three decades. These regional experts were asked to compile the best available information (e.g., sighting, acoustic, tagging, genetic, photo-identification) from scientific literature (including books, peer-reviewed articles, and government or contract reports), unpublished data, personal experience, and other experts' knowledge to delineate the BIAs and create the associated narratives, maps, and metadata tables.

CetMap sought additional review of the BIAs. CetMap recognized the need for support of the BIA assessment process by other scientists, managers, and relevant experts. The scientific community has accepted the peer-review process conducted by scientific journals as a way to evaluate science and syntheses. The review process also helped to ensure that the BIA narratives, maps, and metadata tables were accurate, based on the best available science, presented consistently across regions, and supported by the references cited. BIA drafts were reviewed by CetMap members and by other scientific experts external to the process with experience in particular species and regions, including individuals able to convey traditional ecological knowledge and reviewers who operated under the established guidelines of this journal.

In total, from drafting the original BIA narratives, maps, and metadata tables through the end of the journal's peer-review process, each BIA was reviewed by approximately 7 to 20 experts. The entire assessment was conducted by experts communicating and exchanging information online, over the telephone, or in person.

Assessment Summary

This inaugural assessment identified 131 BIAs for 24 species (including multiple stocks for some species) within the seven regions. These BIAs were based on extensive review and synthesis of published and unpublished information by upwards of 70 experts. To put this assessment into perspective, NOAA Fisheries' *Marine Mammal Stock Assessment Reports* recognize approximately 34 large whale, 61 small whale, and 76 dolphin and porpoise stocks in U.S. waters. A summary of the BIAs identified by region, species, BIA type, and area is provided in Table 1.3. The geographic extent of the BIAs in all regions ranges from 117 km^2 for one Gulf of Mexico bottlenose dolphin small and resident BIA (see LaBrecque et al., 2015) to 373,000 km^2 for the fin whale feeding BIA in the Bering Sea (see Ferguson et al., 2015c). The best estimates of abundance for the small and resident populations identified across all regions range from 10 (belugas in Yakutat Bay, Gulf of Alaska; Ferguson et al., 2015a) to ~2,500 to 3,000 (belugas in Bristol Bay, Alaska; Ferguson et al., 2015c). The spatial extent of the small and resident populations' overall ranges is on the order of 4,000 km^2, though were as small as 117 km^2 for the Gulf of Mexico bottlenose dolphin stock mentioned above and as large as 31,500 km^2 for the Bristol Bay belugas.

There was insufficient available information or time to identify BIAs for the species listed by region below. These species should be considered in subsequent BIA assessments. In the East Coast, common dolphin (*Delphinus delphis*), long- and short-finned pilot whales (*Globicephala melas* and *G. macrorhynchus*, respectively), Risso's dolphin (*Grampus griseus*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), Atlantic spotted dolphin (*Stenella frontalis*), and several stocks of bottlenose dolphins (*Tursiops truncatus*) did not have enough information to be assessed. The

possibility of a minke whale migratory corridor in the East Coast region should be considered in the future as more acoustic data are evaluated.

There was not enough information for most of the cetacean species in the Gulf of Mexico to evaluate whether BIAs should be delineated. Future BIA assessments for the Gulf of Mexico should evaluate potential residency patterns of the sperm whale (*Physeter macrocephalus*) and other deep diving cetaceans that utilize the canyons and shelf break. In the Gulf of Mexico, several stocks of bottlenose dolphin also were not evaluated.

For the West Coast region, fin whales (*Balaenoptera physalus*) were discussed but no BIAs defined due to limited or conflicting information. Other species found in the West Coast region but not evaluated were the minke whale (*Balaenoptera acutorostrata*), killer whale (*Orcinus orca*), beaked whales (family Ziphiidae), and sperm whale.

The main information gaps in the Hawai'i region were most species within the Northwestern Hawaiian Islands, and some species within the western half or along the windward sides of the main Hawaiian Islands.

Species inhabiting the Gulf of Alaska and Aleutian Islands and Bering Sea regions but not evaluated include Dall's porpoise (*Phocoenoides dalli*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), killer whale, beaked whales, sperm whale, minke whale, sei whale (*Balaenoptera borealis*), and harbor porpoise (*Phocoena phocoena*). Additional information gaps identified during the assessment of the Gulf of Alaska region include (1) reproductive areas for fin, gray (*Eschrichtius robustus*), and North Pacific right (*Eubalaena japonica*) whales; (2) detailed information on the migration routes of all species; (3) detailed information on the migratory timing of all species except humpback whales (*Megaptera novaeangliae*); and (4) cetacean distribution, density, and behavior in U.S. Gulf of Alaska waters off the continental shelf. Information gaps identified during the assessment of the Aleutian Islands and Bering Sea region include (1) reproductive areas for all species; (2) detailed information on the migration routes and timing of all species; and (3) cetacean distribution, density, and behavior in U.S. Bering Sea waters off the continental shelf.

For the Arctic region, species lacking sufficient information for assessment include fin, humpback, minke, and killer whales, and harbor porpoise. Other information gaps that were identified during the Arctic BIA process include (1) bowhead whale use of the western Beaufort Sea in summer (e.g., feeding, migration timing, movement rates); (2) the existence or extent of a bowhead whale fall migratory corridor in the Chukchi Sea; (3) the extent and nature of beluga use of outer continental shelf and slope habitat in the Beaufort Sea; (4) the existence or location of gray whale migratory corridors in spring and fall; and (5) the degree to which gray whales move between known feeding hotspots.

Strengths and Limitations of CetMap BIAs

Caveats

CetMap made every effort to minimize biases in the BIAs by requiring that the information used to identify each BIA was fully documented in the references and metadata tables and by undertaking multiple levels of review by qualified experts. Nevertheless, it is the responsibility of the user to understand and keep in mind the following caveats when using the BIAs in planning and decision-making (see also Table 1.4):

- Only U.S. waters were evaluated as part of the BIA assessment; however, available information for non-U.S. areas was considered in identifying BIAs. Therefore, absence of BIA designations outside U.S. waters should not be interpreted as an absence of BIAs in those waters.
- Only areas and periods for which sufficient information was available to determine biological importance, under the criteria established above, were considered for BIA delineation. Therefore, other areas of biological importance to cetaceans exist within U.S. waters but were not included due to insufficient information because data collection and analyses to identify such areas are ongoing or because of time limitations of the assessment process.
- The quantity and type of information used to delineate BIAs within U.S. waters were spatially and temporally heterogeneous and included data derived from visual sightings, passive acoustic monitoring, tagging, genetic samples, photo-identification, and expert knowledge.
- The BIA narratives and metadata tables should be consulted to determine which regions and periods were considered, what data support the designations, and where and when information is lacking.
- The BIA designation is not equivalent to habitat or range. BIAs do not identify the physical and biological factors that characterize a species' habitat. Feeding, migration, and reproduction BIAs highlight specific locations and periods within which critical behaviors occur and likely represent only a fraction of a species' overall range. BIAs may represent only the period when a peak number of individuals use an area. A small and resident population BIA may encompass all or most of the population's

Table 1.3. Count and total area (in km²) of BIAs by region, species, and BIA type. A total of 131 BIAs (58 feeding, 15 migration, 10 reproduction, and 48 small and resident) were defined for 24 species across seven regions in U.S. waters, resulting in a total area of 2,798,466 km².

	Species' scientific name	Species' common name	BIA type	# of BIAs	Total BIA size (km²)
East Coast	*Balaenoptera acutorostrata*	Minke whale	Feeding	2	56,597
	Balaenoptera borealis	Sei whale	Feeding	1	56,609
	Balaenoptera physalus	Fin whale	Feeding	3	27,094
	Eubalaena glacialis	North Atlantic right whale	Feeding	3	16,098
	Eubalaena glacialis	North Atlantic right whale	Migration	1	269,448
	Eubalaena glacialis	North Atlantic right whale	Reproduction	2	51,997
	Megaptera novaeangliae	Humpback whale	Feeding	1	47,701
	Phocoena phocoena	Harbor porpoise	Small and resident	1	12,211
	Tursiops truncatus	Bottlenose dolphin	Small and resident	10	13,867
			Total	**24**	**551,622**
Gulf of Mexico	*Balaenoptera edeni*	Bryde's whale	Small and resident	1	23,559
	Tursiops truncatus	Bottlenose dolphin	Small and resident	11	6,507
			Total	**12**	**30,066**
West Coast	*Balaenoptera musculus*	Blue whale	Feeding	9	16,438
	Eschrichtius robustus	Gray whale	Feeding	6	1,927
	Eschrichtius robustus	Gray whale	Migration	4	263,860
	Megaptera novaeangliae	Humpback whale	Feeding	7	23,098
	Phocoena phocoena	Harbor porpoise	Small and resident	2	4,941
			Total	**28**	**310,264**
Hawai'i	*Feresa attenuata*	Pygmy killer whale	Small and resident	1	2,265
	Globicephala macrorhynchus	Short-finned pilot whale	Small and resident	1	2,968
	Kogia sima	Dwarf sperm whale	Small and resident	1	2,675
	Megaptera novaeangliae	Humpback whale	Reproduction	1	5,846
	Mesoplodon densirostris	Blainville's beaked whale	Small and resident	1	7,442
	Peponocephala electra	Melon-headed whale	Small and resident	1	1,753
	Pseudorca crassidens	False killer whale	Small and resident	1	5,430
	Stenella attenuata	Pantropical spotted dolphin	Small and resident	3	7,252
	Stenella longirostris	Spinner dolphin	Small and resident	5	38,040
	Steno bredanensis	Rough-toothed dolphin	Small and resident	1	7,175
	Tursiops truncatus	Common bottlenose dolphin	Small and resident	4	21,920
	Ziphius cavirostris	Cuvier's beaked whale	Small and resident	1	23,583
			Total	**21**	**126,349**
Gulf of Alaska	*Balaenoptera physalus*	Fin whale	Feeding	1	44,975
	Delphinapterus leucas	Beluga	Small and resident	2	9,209
	Eschrichtius robustus	Gray whale	Feeding	2	7,374
	Eschrichtius robustus	Gray whale	Migration	1	176,921
	Eubalaena japonica	North Pacific right whale	Feeding	1	28,019
	Megaptera novaeangliae	Humpback whale	Feeding	6	93,920
			Total	**13**	**360,418**
Aleutian Islands and Bering Sea	*Balaena mysticetus*	Bowhead whale	Feeding	1	2,130
	Balaena mysticetus	Bowhead whale	Migration	1	19,861
	Balaenoptera physalus	Fin whale	Feeding	1	372,961
	Delphinapterus leucas	Beluga	Feeding	1	61,675
	Delphinapterus leucas	Beluga	Migration	1	22,332
	Delphinapterus leucas	Beluga	Small and resident	1	31,567
	Eschrichtius robustus	Gray whale	Feeding	3	47,866
	Eschrichtius robustus	Gray whale	Migration	3	69,599
	Eubalaena japonica	North Pacific right whale	Feeding	1	92,667
	Megaptera novaeangliae	Humpback whale	Feeding	2	109,619
			Total	**15**	**830,278**

Table 1.3. Count and total area of BIAs by region, species, and BIA type (continued)

	Species' scientific name	Species' common name	BIA type	# of BIAs	Total BIA size (km²)
Arctic	*Balaena mysticetus*	Bowhead whale	Feeding	3	32,998
	Balaena mysticetus	Bowhead whale	Migration	2	193,742
	Balaena mysticetus	Bowhead whale	Reproduction	4	142,755
	Delphinapterus leucas	Beluga	Feeding	1	1,527
	Delphinapterus leucas	Beluga	Migration	2	171,231
	Delphinapterus leucas	Beluga	Reproduction	1	1,527
	Eschrichtius robustus	Gray whale	Feeding	3	27,391
	Eschrichtius robustus	Gray whale	Reproduction	2	18,298
			Total	**18**	**589,469**
			Grand total	**131**	**2,798,466**

entire known range, or may represent high density areas within a larger known range.

- This BIA assessment focused on certain cetacean species. It will be necessary, using other resources, to supplement the areas identified herein with those having high densities of these and other marine mammal species. A similar process could be established for the cetacean, pinniped, sirenian, and fissiped species that were not addressed by this effort.

No Thresholds

To maximize the number of species, areas, and times that could be evaluated under CetMap's BIA criteria, CetMap chose to not incorporate thresholds (quantitative values) into the criteria. The implementation of thresholds into assessment processes requires a considerable amount of data of a certain type and quality, and those data standards are difficult to meet in most regions. The variability in the geographic extent of BIAs in this assessment (Table 1.3) is partially due to the heterogeneity in the type and quality of data used; however, each BIA is substantiated by an associated narrative, map, and metadata table, allowing transparency into the delineation process. Furthermore, CetMap encourages users to incorporate information from multiple sources, including BIAs and HD models

Table 1.4. The caveats below should be considered when using BIAs in planning or decision-making processes.

1	Only U.S. waters were evaluated as part of the BIA assessment; however, available information for non-U.S. areas was considered in identifying BIAs. Therefore, absence of BIA designations outside U.S. waters should not be interpreted as an absence of BIAs in those waters.
2	Only areas and periods for which sufficient information was available to determine biological importance under the criteria established above were considered for BIA delineation. Therefore, other areas of biological importance to cetaceans exist within U.S. waters but were not included due to insufficient information because data collection and analyses to identify such areas are ongoing or because of time limitations of the assessment process.
3	The quantity and type of information used to delineate BIAs within U.S. waters were spatially and temporally heterogeneous and included data derived from visual sightings, passive acoustic monitoring, tagging, genetic samples, photo-identification, and expert knowledge.
4	The BIA narratives and metadata tables should be consulted to determine which regions and periods were considered, what data support the designations, and where and when information is lacking.
5	The BIA designation is not equivalent to habitat or range. BIAs do not identify the physical and biological factors that characterize a species' habitat. Feeding, migration, and reproduction BIAs highlight specific locations and periods within which critical behaviors occur and likely represent only a fraction of a species' overall range. BIAs may represent only the period when a peak number of individuals use an area. A small and resident population BIA may encompass all or most of the population's entire known range, or may represent high density areas within a larger known range.
6	This BIA assessment focused on certain cetacean species. It will be necessary, using other resources, to supplement the areas identified here with those having high densities of these and other marine mammal species. A similar process could be established for the cetacean, pinniped, sirenian, and fissiped species that were not addressed by this effort.

or stratified density estimates, to inform conservation and management decisions.

Expert Elicitation

The expert elicitation process used in this BIA assessment is both a strength and a limitation. There is an urgent need for input into decisions regarding conservation and management and a lack of data for quantitative analyses (Kot et al., 2010; Kaschner et al., 2012). Managers are asked to make decisions given the best available information (or limitations thereof), and scientists are asked to provide input (professional judgments and interpretations) even when information is limited. Expert elicitation allows for the interpretation and synthesis of various sources of information, such as empirical data, scientific literature, and personal field experience, to make existing knowledge directly applicable to management (Teck et al., 2010).

Expert elicitation is not purely objective, but neither are empirical data collection and analysis methods in general. All science requires judgments to be made at multiple points in the scientific process: defining the question; choosing the study area; creating the study design; deciding on and implementing data collection methods; analyzing data, including the identification and treatment of outliers; deciding on the analytical spatial and temporal extent and scale; subsetting data; identifying and computing parameters of interest; choosing an overall analytical paradigm (e.g., frequentist, Bayesian, or likelihood statistical approaches); and presenting and interpreting results.

CetMap incorporated safeguards into several steps of the expert elicitation process: (1) enlisting experts with knowledge about cetaceans in particular regions, acquired through personal experience conducting research (field work and analyses); (2) facilitating transparency of the BIA assessment process by providing details about methodology, assumptions, and rationale in the narratives, and providing details about the information used in the narratives, metadata tables, and references; (3) fostering support for the BIAs by undertaking an extensive expert review phase for narratives, maps, and metadata tables, including reviewers designated by the journal and those who were external to the journal's official peer-review process; and (4) recognizing that this is a first step in an iterative process, and encouraging these inaugural BIAs to be reviewed and revised in the future as new information becomes available.

Future Directions for CetMap BIAs

CetMap's BIA assessment process should be considered an iterative process. As noted above, BIAs are limited by available knowledge, and they are not intended to provide a complete list of areas of biological importance for all cetacean species. NOAA regards the information presented on the CetMap website, including the BIAs, to be living resources, which will be maintained and updated as new information becomes available. This inaugural set of BIAs represents a snapshot in time. As new empirical data are gathered, these BIAs can be calibrated to determine how closely they correspond to reality, and they can be updated as necessary. Future assessments should consider methods for incorporating uncertainty into the BIA delineation process. In addition, the number of cetacean species (within a given region and time period) represented in the BIA library is likely to expand as knowledge accumulates. Furthermore, decisionmakers and the scientific community might find it helpful to have information about BIAs for pinnipeds, sirenians, and fissipeds. When planning future BIA assessments, it will be important to account for the time required to undertake the process. This entire elicitation process, starting with CetMap's initial workshop in January 2011 and finishing with publication in March 2015, took approximately four years.

Comparison to International Assessments

The CetMap BIA assessment is part of a growing international effort to delineate areas of biological or ecological importance to inform decisions or promote actions in the conservation and management realm. Herein, we compare CetMap BIAs to IUCN KBAs and IMMAs, CBD EBSAs, PWLF ICAs, and Australian BIAs (Table 1.5). Although IMMAs are still in development (Corrigan et al., 2014), and KBA criteria are in revision (IUCN, 2013b), sufficient information exists to compare the proposed assessment to the collection of existing assessments. It should be noted that other detailed regional assessments exist, including the Bering Strait Marine Life and Subsistence Use Data Synthesis (Oceana & Kawerak, Inc., 2014) and the Arctic Synthesis compiled by Audubon Alaska and Oceana (Smith, 2010). We chose to focus on the assessments in Table 1.5 because they are most similar to the CetMap BIA process.

The suite of assessments listed above and summarized in Table 1.5 share a collection of common characteristics. First, all of these examples are proactive efforts to identify important areas. They are not responses to specific actions or developments; rather, they address multiple existing and growing environmental concerns in the marine, freshwater, or terrestrial environment. Second, all efforts are based on the best available science and rely on expert judgment to shape the criteria and conduct the assessment. Third, they are all iterative processes. Recognizing that our understanding of the marine environment is under

Table 1.5. Comparison of CetMap's BIA assessment to five similar international assessments; QT = Quantitative Thresholds.

	Oversight body	Definition	Criteria	QT	Taxa	Ecological unit assessed	Geographic scope	Political scale	Habitats targeted
CetMap BIAs	NOAA Fisheries Cetacean Density and Distribution Mapping Working Group	BIAs are reproductive areas, feeding areas, migratory corridors, and areas in which small and resident populations are concentrated.	(1) *Reproductive areas:* Areas and times within which a particular species selectively mates, gives birth, or is found with neonates or calves. (2) *Feeding areas:* Areas and times within which aggregations of a particular species preferentially feed. These either may be persistent in space and time or associated with ephemeral features that are less predictable but are located within a larger area that can be delineated. (3) *Migratory corridors:* Areas and times within which a substantial portion of a species is known to migrate; the corridor is spatially restricted. (4) *Small and resident population:* Areas and times within which small and resident populations occupy a limited geographic extent	No	Cetaceans	Populations, stocks, species	United States	Regional	Marine
KBA	IUCN World Commission on Protected Areas and Species Survival Commission Joint Task Force on Biodiversity and Protected Areas	Areas that contribute significantly to the global persistence of biodiversity[6]	*Proposed criteria*[5]: (1) Sites contributing significantly to the global persistence of threatened biodiversity; (2) Sites contributing significantly to the global persistence of geographically restricted biodiversity; (3) Sites contributing significantly to the global persistence of biodiversity because they are exceptional examples of ecological integrity and naturalness; (4) Sites contributing significantly to the global persistence of outstanding biological processes; and (5) Sites contributing significantly to the global persistence of biodiversity as identified through a comprehensive quantitative analysis of irreplaceability	Yes[5]	Unrestricted	Gene, population, species, or ecosystem[4, 6]	Global[6]	Regional[6], national, international	Terrestrial, freshwater, and marine[6]

Table 1.5. Comparison of CetMap's BIA assessment to five similar international assessments; QT = Quantitative Thresholds. (continued)

	Oversight body	Definition	Criteria	QT	Taxa	Ecological unit assessed	Geographic scope	Political scale	Habitats targeted
EBSA	Conference of the Parties (COP) to the Convention on Biological Diversity	Ecologically and biologically significant areas are geographically or oceanographically discrete areas that provide important services to one or more species/ populations of an ecosystem or to the ecosystem as a whole, compared to other surrounding areas or areas of similar ecological characteristics, or otherwise meet the criteria as identified in Annex I to decision IX/20.[2]	(1) Uniqueness or rarity; (2) Special importance for life history stages of species; (3) Importance for threatened, endangered, or declining species and/or habitats; (4) Vulnerability, fragility, sensitivity, or slow recovery; (5) Biological productivity; (6) Biological diversity; and (7) Naturalness[2]	No	Unrestricted	Population, species, or ecosystem[2]	Global[2,3]	Regional,[2,3] national, international	Marine[2,3]
ICA[9]	Pacific WildLife Foundation (PWLF)	Important Cetacean Areas (ICAs) are discrete areas of ocean that are of importance to cetaceans for feeding, breeding, and migration activities.	(1) Endangered, threatened, or vulnerable species; (2) Feeding concentrations; (3) Breeding area or nursery; (4) Migration corridors; and (5) Species diversity	Yes	Cetaceans	Population, subspecies, species	British Columbia and Southeast Alaska	Regional, international	Marine

Table 1.5. Comparison of CetMap's BIA assessment to five similar international assessments; QT = Quantitative Thresholds. (continued)

	Oversight body	Definition	Criteria	QT	Taxa	Ecological unit assessed	Geographic scope	Political scale	Habitats targeted
Australian BIA	Australian Government Department of the Environment	Biologically important areas are areas that are particularly important for the conservation of protected species and where aggregations of individuals display biologically important behaviour such as breeding, foraging, resting, or migration.[10]	(1) Breeding; (2) Foraging; (3) Resting; and (4) Migration[10]	No	Seabirds, cetaceans, pinnipeds, sirenians, marine turtles, fishes[11]	Species	Australia	Regional, national	Marine
IMMA	IUCN Marine Mammal Protected Areas Task Force	Sites that contribute significantly to the global persistence of marine mammal biodiversity[1]	*Proposed criteria*[1]: (1) Reproductive areas and times; (2) Feeding areas and times; (3) Migration corridors; (4) Smaller or resident populations; (5) Abundance estimates and population structure (with consideration of rarity, uniqueness, genetic isolation, irreplaceability, size of populations, and temporal aggregations); (6) 3-D habitat features; and (7) Considerations of vulnerability and resilience	Yes[1]	Cetaceans, pinnipeds, sirenians, fissipeds[1]	Population, species[1]	Global	Regional,[1] national, international	Marine, freshwater, terrestrial

Sources

[1]Corrigan et al. (2014). These are proposed criteria.
[2]CBD (2008)
[3]CBD (2010)
[4]IUCN (2013a)
[5]IUCN (2013b)
[6]IUCN (2012)
[9]PWLF (2013)
[10]Australian Government Department of Sustainability, Environment, Water, Population, and Communities (DSEWPaC) (2012)
[11]Australian Government Department of the Environment (2014)

continual revision and to ensure that the areas identified under each assessment continue to represent the best available science, it is necessary to review and revise the areas on a cycle that tracks the acquisition of new information.

There are several noteworthy differences among the assessments, which are highlighted in Table 1.5. For example, the ecological units assessed to delineate KBAs and EBSAs range from genes (for KBAs) or populations (both) to ecosystems and consider all taxa and habitats (CBD, 2008; IUCN, 2012, 2013a). ICAs (PWLF, 2013), Australian BIAs (DSEWPaC, 2012), IMMAs (Corrigan et al., 2014), and CetMap BIAs are based on populations, stocks, or species. Australian BIAs are restricted to marine habitats and include seabirds, cetaceans, pinnipeds, sirenians, marine turtles, and fishes (DSEWPaC, 2012). IMMAs will include all species of cetaceans, pinnipeds, sirenians, and fissipeds, and will encompass terrestrial, marine, and freshwater habitats (Corrigan et al., 2014). ICAs (PWLF, 2013) and CetMap BIAs currently include only cetaceans. The geographic scope and political scale vary among the efforts. The KBA (IUCN, 2012), EBSA (CBD, 2008, 2010), and IMMA (Corrigan et al., 2014) efforts are global, and areas are identified at geographic scales ranging from regional (a portion of a nation), national (at the level of a single nation), or international (crossing national boundaries). ICAs are restricted to waters off British Columbia and Southeast Alaska (PWLF, 2013). ICA boundaries can cross national borders but are also identified at the regional scale (PWLF, 2013). Australian (DSEWPaC, 2012) and CetMap BIAs are restricted to national waters but are delineated at the regional scale. In general, KBAs tend to be smaller than EBSAs, and IMMAs are expected to be similar in size to KBAs (Hoyt & Notarbartolo di Sciara, 2014).

Understanding the goals and the intended use of the designated sites is critical to understanding whether and how the different types of areas can be integrated or nested. KBAs are defined as "areas that contribute significantly to the global persistence of biodiversity" (IUCN, 2012, p. 10). KBA delineation is meant to "help national government agencies, decision makers, resource managers, local communities, the private sector, donor agencies, and others to target the implementation of site conservation standards" (IUCN, 2013a, p. 3). KBA size and the location of their boundaries "should be based on actual or potential manageability for conservation or biodiversity" (IUCN, 2012, p. 21). Therefore, KBA delineation is somewhat constrained by political, socioeconomic, and legal factors. Furthermore, the proposed KBA criteria are based on quantitative thresholds (IUCN, 2013b).

In the EBSA delineation process, there is less focus on management and more emphasis on ecology and biology. EBSAs are defined as "geographically or oceanographically discrete areas that provide important services to one or more species/populations of an ecosystem or to the ecosystem as a whole, compared to other surrounding areas or areas of similar ecological characteristics" (CBD, 2008, p. 181). Furthermore, the Conference of the Parties to the CBD (2010) noted that "the application of the ecologically or biologically significant areas (EBSAs) criteria is a scientific and technical exercise" (p. 234) and that "areas found to meet the criteria may require enhanced conservation and management measures" (p. 234). EBSA delineation does not require the evaluation of quantitative thresholds. Criteria for KBAs (IUCN, 2013b) and EBSAs (CBD, 2008) include vulnerability to disturbances, which ultimately involves assessment of threats, risks, and, potentially, cumulative effects analyses. Although still in development, IMMAs are anticipated to "nest fully within what would constitute an EBSA, and either fully or to at least a large degree within KBAs" (Corrigan et al., 2014, p. 181; see also Hoyt & Notarbartolo di Sciara, 2014). KBAs (IUCN, 2013b), EBSAs (CBD, 2008), and ICAs (PWLF, 2013) all include a criterion regarding endangered, threatened, or vulnerable species. In addition, ICAs include some quantitative thresholds (PWLF, 2013). The Australian (DSEWPaC, 2012) and CetMap BIAs are more similar to each other than to the other assessments because they are not based on thresholds, and they do not directly incorporate vulnerability criteria; rather, they can be considered purely behavior or activity "layers" that can be input into management decisions, cumulative effects models, or other assessment processes (i.e., KBAs, EBSAs, and/or IMMAs), along with other factors relevant to the particular issue at hand.

Conclusions

The CetMap BIAs are one in a growing international collection of tools created to assist multiple stakeholders in the characterization, analysis, and minimization of anthropogenic impacts on cetaceans, other taxa, and ecosystems. All of the tools require regular review and revision to track emerging knowledge and understanding about the species and ecosystems of concern. Communication among those overseeing each assessment process will be critical in order to share limited resources (i.e., time, money, and knowledge) and to enhance understanding of how the products from each assessment can be integrated.

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