Presence, Abundance, Distribution, Density, Habitat Use and Population Trends

Many entities conduct surveys and research on marine taxa that can contribute to our broader understanding of the spatial and temporal distribution and density of marine mammals within their ranges. NOAA's mandate includes the responsibility to collect the data necessary to support broad-scale and long-term species or stock assessments of protected species. While other datasets provide very useful information (addressed below in each taxa section), a look at NOAA's data for marine mammals and ESA-listed species provides the best overview of the status of the comprehensive large-scale survey data that can be used (if collected with adequate frequency) to estimate abundance and population trends, as well as density and distribution. Additionally, in response to the requirements of the Government Performance and Results Act (GPRA), NOAA developed a method for ranking the adequacy of its stock assessments based on factors such as the frequency of surveys, the quality of the abundance estimate, available information on stock structure, and our understanding of anthropogenic impacts (Table B-1). Using these taxa-specific factor rankings, NOAA further established that an overall Tier 2 ranking is necessary for an assessment to be considered "adequate," and identified how that could be achieved (see Tables B-4 to B-7 at the end of this Appendix). While broadly valuable, note that GPRA ranks are qualitative and can be somewhat subjective, and it is difficult to draw conclusions across years when stocks or species are split. NOAA also tracks the population trends of ESA-listed species (Table B-2).

Additionally, the ESA provides for the designation of Critical Habitat and the development of Recovery Plans for listed species. Critical habitat designations delineate areas of particular importance for ESA-listed species and explicitly describe the "primary constituent elements" of the designated Critical Habit, or what makes that habitat important. Recovery Plans, which are used to promote the conservation of the species and identify the thresholds for de-listing, include details of what is known about the biology of the species, specific threats, and a recovery strategy that lays out specific conservation measures.

Below, we summarize the availability of NOAA data using the GPRA information, as well as the availability of ESA Recovery Plans and Critical Habitat designations (Table B-3). All information related to ESA-listed species, including links to all Recovery Plans and designated Critical habitat, may be found here: http://www.nmfs.noaa.gov/pr/species/esa/listed.htm. Where available, we highlight in the next sections the other types of taxa-specific data available to characterize presence, abundance, density, distribution, habitat use, and population trends for the different taxa.

Additional Information: Marine Mammals

NOAA's stock assessment reports for marine mammals, which may be found at (http://www.nmfs.noaa.gov/pr/sars/species.htm), provide estimated abundance and population trends for all marine mammal species, as well as a summary of other important information such as the range of the species and anthropogenic threats. Beyond what is noted above, about 47% of the stocks have either never had an assessment conducted, or the last one was over 10 years ago.

When robust survey data are available (from NOAA or otherwise), they may also be used, either alone or in combination with measures of environmental data known to be correlated with marine mammal presence to provide spatio-temporally explicit marine mammal density and distribution predictions. OBIS-SEAMAP (http://seamap.env.duke.edu) houses a tremendous amount of marine mammal observation data, in the form of both raw data and processed density and habitat suitability models. In

NOAA's CetMap website (http://cetsound.noaa.gov), available data and density models are presented, characterized, and provided in a manner that allows users to quickly determine what types of data are available within a region for a particular stock. The CetMap website also includes the description and results of an effort to identify "biologically important areas" for cetaceans, e.g., areas where cetaceans are known to concentrate for reproductive behaviors, feeding, or migration, or areas with small and resident populations of cetaceans. Generally speaking, the highest quality habitat-based density estimates are only available for a subset of species and only for the summer months.

Additional Information: Fishes

NOAA works with the regional fishery management councils to identify the "Essential Fish Habitat (EFH)" for every life stage of each federally managed species using the best available scientific information. Essential fish habitat includes all types of aquatic habitat—wetlands, coral reefs, seagrasses, rivers—where fish spawn, breed, feed, or grow to maturity. Essential fish habitat has been described for approximately 1,000 managed species to date. NOAA and the councils also identified more than 100 "habitat areas of particular concern" or HAPCs. These are considered high priority areas for conservation, management, or research because they are rare, sensitive, stressed by development, or important to ecosystem function. NOAA has created an "EFH Mapper," which is a one-stop tool for viewing the spatial representations of fish species, their life-stages and important habitats (http://www.habitat.noaa.gov/protection/efh/habitatmapper.html).

Finally, NOAA Fisheries provides stock assessment advice in support of fishery status determinations, setting annual catch limits, and management of sustainable fisheries. Information, including the percentage of stocks with adequate assessments based on the Fish Stock Sustainability Index (FSSI; 230 stocks selected for their importance to commercial and recreational fisheries), is tracked on a quarterly and annual basis in order to measure performance of the national stock assessment program. Adequate assessments are conducted using production models or, better, have been validated by a regional review, and are no more than five years old. This information is available here: (http://www.nmfs.noaa.gov/sfa/fisheries_eco/status_of_fisheries/).

Table B-1. Summary of overall 2013 Tier ratings of assessment quality for marine mammal stocks and ESA-listed species (fish, invertebrates, and sea turtles). "3" is best, "2" is adequate, "1" and "0" are progressively worse. Tables B-4 to B-7 describe how the stocks are ranked.

ALL MARINE MAMMALS						
Tier Levels	**SWFSC**	**NWFSC**	**PIFSC**	**AFSC**	**NEFSC**	**SEFSC**
0	6	0	28	0	0	0
1	19	0	92	32	16	83
2	14	1	5	19	8	7
3	0	0	0	0	1	0
Total # of Stocks	39	1	125	52	25	90
% with overall rank >= Tier 2 (adequate)	**36%**	**100%**	**4%**	**37%**	**36%**	**8%**
ESA-LISTED FISH						
Tier Levels	**SWFSC**	**NWFSC**	**PIFSC**	**AFSC***	**NEFSC**	**SEFSC**
0	0	0			0	0
1	11	4			8	14
2	0	18			1	1
3	0	0			1	0
Total # of Species	11	22			10	15
% with overall rank >= Tier 2 (adequate)	**0%**	**82%**			**20%**	**7%**
ESA-LISTED SEA TURTLES						
Tier Levels	**SWFSC**	**NWFSC**	**PIFSC**	**AFSC***	**NEFSC**	**SEFSC**
0	1		0			0
1	2		2			2
2	0		0			0
3	0		0			0
Total # of Species	3		2			2
% with overall rank >= Tier 2 (adequate)	**0%**		**0%**			**0%**
ESA-LISTED MARINE INVERTEBRATES						
Tier Levels	**SWFSC**	**NWFSC**	**PIFSC**	**AFSC***	**NEFSC**	**SEFSC**
0	0					0
1	2					2
2	0					0
3	0					0
Total # of Species*	2					2
% with overall rank >= Tier 2 (adequate)	**0%**					**0%**
*Note that 20 new coral species were listed in 2014						

Table B-2. Trends of numbers of populations/stocks of indicated taxa ("mixed" indicates when there are multiple populations of same species and some are increasing and some are decreasing).

	Number of Species with Indicated Population Trends					
	increasing	stable	mixed	declining	unknown	unranked
ESA-listed Marine Mammals	7	3	4	1	13	3
ESA-listed Fish	2	16	4	1	14	5
ESA-listed Sea Turtles	2	0	5	0	1	0
ESA-listed Invertebrates	0	0	0	2	2	0

Table B-3. Number of ESA-listed species or Distinct Population Segments for each taxa along with number of final critical habitat designations and recovery plans.

	# ESA-listed species or DPSs	# species critical habitat designated	# recovery plans finalized
Marine Mammals	31	6	10
Fish	53	10	16
Sea Turtles	16	5	11
Invertebrates	24	4	1

Table B-4. Factors used in evaluating marine mammal stock assessments. Note that ESA-listed or MMPA depleted species must be ranked 3 in all categories to be considered Tier 2 overall (adequate), whereas non-listed or depleted marine mammals are considered overall Tier 2 when ranked at least 2 in all categories.

Category/ Level for Tier Rating	Description
Stock Identification	
0	No information (qualitative or otherwise) available
1	Structure inferred from analyses undertaken for other purposes (e.g., distribution, differences in trends, differences in life history)
2	Structure inferred from an analysis specifically aimed at investigating population differentiation (e.g., pollutants, stable isotopes, genetics, tagging)
3	Structure inferred from an integrative analysis of at least two lines of evidence of the type listed under Level 2
4	Estimates of dispersal rate that include estimates of uncertainty
Abundance	
0	No information (qualitative or otherwise) available
1	Minimum count, abundance estimate, or index count
2	Unbiased estimate of abundance (CV≥30%)
3	Unbiased estimate of abundance (CV<30%) with seasonally OR geographically-explicit density
4	Seasonal and geographic-specific density estimates
Anthropogenic Impacts	
0	No information (qualitative or otherwise) available
1	Qualitative evidence of anthropogenic impacts
2	Minimum estimate of anthropogenic impacts
3	Unbiased estimate of anthropogenic impacts (CV≥30%)
4	Precise estimate of anthropogenic impacts (CV<30%) OR no evidence of human-induced mortality
Assessment Quality	
0	No assessments conducted
1	Assessment with minimum abundance or index only
2	Assessment using simple deterministic models with defaults or proxies
3	Assessment using more advanced deterministic models without defaults or proxies
4	Assessment using species-specific sophisticated models, such as stochastic models, depletion models, or projection models (e.g., population viability analysis, PVA)
Assessment Frequency	
0	No assessment conducted
1	Most recent assessment is ≥10 years old
2	Most recent assessment is 6-9 years old
3	Most recent assessment is 2-5 years old
4	Most recent assessment is ≤ 1 year old

Table B-5. Factors used in evaluating ESA-listed fish species assessments. Note that a species must be ranked 3 in all categories to be considered Tier 2 overall (adequate).

Categor	Short Description	Long Description ("metadata")
Stock Identification		
0	No information (qualitative or otherwise) available	No information (qualitative or otherwise) available.
1	Structure inferred from analyses undertaken for other purposes (e.g., distribution, differences in trends, differences in life history)	Structure inferred from analyses undertaken for other purposes (e.g., distribution, differences in trends, differences in life history).
2	Structure inferred from an analysis specifically aimed at investigating population differentiation (e.g., pollutants, stable isotopes, genetics, tagging)	Structure inferred from an analysis specifically aimed at investigating population differentiation (e.g., pollutants, stable isotopes, genetics, tagging).
3	Structure inferred from an integrative analysis of at least two lines of evidence of the type listed under Level 2	Structure inferred from an integrative analysis of at least two lines of evidence of the type listed under Level 2.
4	Estimates of dispersal rate that include estimates of uncertainty	Estimates of dispersal rate that include estimates of uncertainty.
Abundance		
0	None	No abundance data.
1	Fishery CPUE or imprecise survey with size composition	Relative abundance index from fishery CPUE or an imprecise, infrequent survey. Another Level 1 situation would be a single survey from which an estimate of absolute abundance has been made. At this low level of information, there will only be a limited ability to track changes in stock abundance because of uncertainties in the calibration of the index, or a high level of noise in the data relative to the magnitude of the expected changes in stock abundance.
2	Precise, frequent survey with age composition	Precise, frequent surveys with age composition will provide more accurate tracking of changes in stock abundance and the associated age composition date will enable better estimation of historical and current levels of recruitment.
3	Survey with estimates of q	Research surveys with known or estimated catchability, acoustic surveys with known or estimated target strengths, and statistically designed tagging studies can provide estimates of absolute abundance. This is especially valuable when the time series of the survey is so short that no trend is detectable.
4	Habitat-specific survey	Habitat-specific surveys refine the concept of stratified random surveys so that survey results are more closely associated with particular habitats. The result is improved knowledge of the relationship between fish assemblages and habitat features. In addition, these surveys use alternative methodologies to extend survey coverage into all relevant habitats.
Life History		
0	None	No life history data.
1	Size	The size composition of harvested fish provides a simple index of a stock's potential and vulnerability to overharvesting.
2	Basic demographic parameters	Basic demographic parameters such as age, growth, and maturity rates provide information on productivity and natural mortality.
3	Seasonal or spatial information (mixing, migration)	Seasonal and spatial patterns of mixing, migration, and variability in life history characteristics, especially growth and maturity, provide improved understanding of how a population responds to its environment.
4	Food habits data	Food habits information defines predator-prey and competitive relationships within the fish community, thus providing a first step towards direct estimation of natural mortality rates and ecologically-based harvest recommendations.
Catch		
0	None	No catch data.
1	Landed catch	Landed catch provides a minimum estimate of fishery removals and is typically obtained from mandatory landing receipts. In some cases, particularly recreational fisheries, a statistical sampling program is used to expand estimates of sampled catch up to the total angling population.
2	Catch size composition	Catch size composition provides a measure of the sizes of fish being impacted by the fishery, and when tracked over time can provide an index of recruitment to the fishery and total mortality rates.
3	Spatial patterns (logbooks)	Spatial data on catch from logbooks can provide information on range extensions and contractions, and other changes in fleet or distribution.
4	Catch age composition	Catch age composition requires development of age determination techniques and an investment in the collection and processing of appropriate samples. The result is much greater stock assessment accuracy than can be obtained with size composition data alone.
5	Total catch by sector (observers)	Accurate and complete data on total removals (including landed catch, discards, bycatch in other fisheries, and cryptic mortality included by fishing gear contact) will contribute to accurate stock assessment results. An at-sea observer program can monitor total removals, cross-check logbook data, and collect site-specific biological samples. In many fisheries, the relative merits of observer programs for collecting data on total removals and/or age composition data may warrant consideration before or instead of investing in a fishery logbook program.
Anthropogenic Impacts other than Catch		
0	None	No information on human-caused impacts on survival or other demographic parameters.
1	Primary sources, with uncertainty or incompleteness	Primary sources of anthropogenic impacts have been identified, but the list is uncertain or incomplete and there is no quantitative information relating risk factors to demographic parameters.
2	Most primary sources identified, some quantified	Most primary sources of anthropogenic impacts have been identified and have been at least somewhat quantified based on literature reviews or data from other populations or species, or some sources may be accurately quantified but other potentially important sources of mortality remain unquantified.
3	All primary sources identified and somewhat quantified	All primary sources of anthropogenic impacts have been identified and have been at least somewhat quantified based on literature reviews or data from other populations or species, or some sources may be accurately quantified but other potentially important sources of mortality remain unquantified.
4	All primary sources identified and accurately quantified	All primary sources of anthropogenic mortality have been identified and accurately quantified.
Assessment/Model Quality		
0	None	Although some data may have been collected on this species, these data have not been examined beyond simple time series plots or tabulations of catch.
1	Index only (commercial or research CPUE)	Either: a) a time series of a (potentially-imprecise) abundance index calculated as raw or standardized CPUE in commercial, recreational, or survey vessel date, or b) a one-time estimation of absolute abundance made on the basis of tagging results, a depletion study, or some form of calibrated survey.
2	Simple life history equilibrium models	Simple equilibrium models applied to life history information. For example, yield per recruit or spawner per recruit functions based on mortality, growth, and maturity schedules; catch curve analysis; survival analysis; or length-based cohort analysis.
3	Aggregated population models	Equilibrium and non-equilibrium production models aggregated both spatially and over age and size; for example, the Schaefer model and the Pella-Tomlinson model.
4	Size/age/stage-structured models	Size, stage, or age-structured models such as cohort analysis and untuned and tuned VPA analyses, age-structured production models, CAGEAN, stock synthesis, size or age-structured Bayesian models, modified DeLury methods, and size or age-based mark-recapture models.
5	Add ecosystem (multispecies, environment), spatial, and seasonal analyses	Assessment models incorporating ecosystem considerations and spatial and seasonal analyses in addition to Levels 3 or 4. Ecosystem considerations include one or more of the following: a) one ore more time-varying parameters, either estimated as constrained series, or driven by environmental variables, b) multiple target species as state variables in the model, or c) living components of the ecosystem other than the target species included as state variables in the model.
Assessment Frequency		
0	No assessment conducted	Never: an assessment has never been conducted.
1	Most recent assessment is ≥10 years old	Infrequent: the most recent assessment was conducted more than three years ago.
2	Most recent assessment is 6-9 years old	Frequent or recent: the most recent assessment was conducted with in the last three years.
3	Most recent assessment is 2-5 years old	Annual or more: assessments are conducted at least annually.
4	Most recent assessment is ≤ 1 year old	

Table B-6. Factors used in evaluating ESA-listed sea turtle species assessments. Note that a species must be ranked 3 in all categories to be considered Tier 2 overall (adequate).

Categor	Description
Stock Identification	
0	No information (qualitative or otherwise) available
1	Structure inferred from analyses undertaken for other purposes (e.g., distribution, differences in trends, differences in life history)
2	Structure inferred from an analysis specifically aimed at investigating population differentiation (e.g., pollutants, stable isotopes, genetics, tagging)
3	Structure inferred from an integrative analysis of at least two lines of evidence of the type listed under Level 2
4	Estimates of dispersal rate that include estimates of uncertainty
Abundance: Nesting	
0	No information (qualitative or otherwise) available
1	Minimum count, abundance estimate, or index count
2	Unbiased estimate of abundance (CV≥30%)
3	Unbiased estimate of abundance (CV<30%) with seasonally OR geographically-explicit
4	Seasonal and geographic-specific density estimates
Abundance: In-Water	
0	No information (qualitative or otherwise) available
1	Minimum count, abundance estimate, or index count
2	Unbiased estimate of abundance (CV≥30%)
3	Unbiased estimate of abundance (CV<30%) with seasonally OR geographically-explicit
4	Seasonal and geographic-specific density estimates
Life History	
0	No information
1	Basic life history understood
2	Some age/stage parameters available
3	Age/stage parameters fully specified with uncertainty estimates
4	Temporal and/or spatial information available
Anthropogenic Impacts	
0	No information (qualitative or otherwise) available
1	Qualitative evidence of anthropogenic impacts
2	Minimum estimate of anthropogenic impacts
3	Unbiased estimate of anthropogenic impacts (CV≥30%)
4	Precise estimate of anthropogenic impacts (CV<30%) OR no evidence of human-induced
Assessment Quality	
0	No assessments conducted
1	Assessment with minimum abundance or index only
2	Assessment using simple deterministic models with defaults or proxies
3	Assessment using more advanced deterministic models without defaults or proxies
4	Assessment using species-specific sophisticated models, such as stochastic models, depletion models, or projection models (e.g., population viability analysis, PVA)
Assessment Frequency	
0	No assessment conducted
1	Most recent assessment is ≥10 years old
2	Most recent assessment is 6-9 years old
3	Most recent assessment is 2-5 years old
4	Most recent is ≤ 1 year old

Table B-7. Factors used in evaluating ESA-listed invertebrate assessments. Note that 2 species of abalone must be ranked 3 in all categories to be considered Tier 2 overall (adequate), but coral need only be ranked 2 across all factors to achieve overall Tier 2 rank.

Categor	Short Description	Long Description ("metadata")
Stock Identification		
0	None	No information (qualitative or otherwise) available.
1	Inferred from distribution and abundance	Structure inferred from spatial and temporal distribution and abundance.
2	Inferred from phenotypic and life history differences	Structure inferred from geographic variability in phenotypic and life history characteristics (e.g., morphological traits, contaminant profiles, parasite levels, fatty acid composition, elemental stable isotope composition, and life history characteristics such as fecundity, growth rate, size- and age-at-maturity, etc.). Phenotypic traits may be subject to environmental as well as genetic influences.
3	Inferred from genetics or applied tagging	Structure inferred from an analysis of population differentiation using techniques that are independent of environmental influences (e.g., genetics, applied tagging) and that provide estimates of migration rate (as larvae, juveniles, or adults) together with estimates of uncertainty.
4	Inferred from 2 lines of evidence from Level 3	Structure inferred from an integrative analysis of at least 2 lines of congruent evidence of the type listed under Level 3.
Abundance		
0	No information (qualitative or otherwise) available	No abundance data are available.
1	Minimum count or abundance estimates and/or imprecise presence/absence survey, e.g., presence/absence surveys	Relative abundance or occurrence index from presence-absence surveys. At this low level of information, there will only be a limited ability to track changes in stock abundance.
2	Qualitative surveys	Qualitative surveys providing density estimates, e.g., the use of randomly selected transects and quadrants for sessile animals will provide more accurate tracking of changes in stock abundance and will enable better estimation of current status relative to historical abundance.
3	Precise, quantitative surveys with size, age, and sex composition	Quantitative research surveys, as per Level 2, with known or estimated statistical power able to detect an acceptable level of change in density. The collection of size, age, and sex data (for sexually dimorphic species) will provide a means to statistically measure changes in size and age distributions and sex composition, as well as recruitment strength.
4	Precise, quantitative surveys, and in Level 3, conducted seasonally and habitat-specific	Habitat-specific quantitative surveys, as per Level 3, which employ the concept of stratified random surveys so that results are closely associated with particular habitats. This type of survey will result in improved knowledge of the relationship between invertebrate assemblages and habitat features.
Life History		
0	None	No life history data are available.
1	Size composition data	Size composition data, if representative of population size structure, provide a general idea of population growth and mortality (through modal progression analysis) and can be indicative of strong year classes and pulses in recruitment.
2	Basic demographic characteristics	Information on basic demographic characteristics, such as age structure, growth, maturity, and fecundity, helps estimate productivity and natural mortality.
3	Seasonal and spatial information	Data on seasonal and spatial variability in life history characteristics provide improved understanding of how a population responds to its environment.
4	Food habits and trophic interactions	Information on food habits that structure trophic interactions within the community, such as predator-prey and competitive relationships, provides a step towards better understanding and more reliable estimation of natural mortality and helps develop ecosystem-based management recommendations.
Threats		
0	None	No information on threats to survival or other demographic parameters.
1	Primary sources, with uncertainty or incompleteness	Primary sources of threats have been identified, but the list is uncertain or incomplete and there is no quantitative information relating risk factors to demographic parameters.
2	Most primary sources identified, some quantified	Most primary sources of threats have been identified and have been at least somewhat quantified based on literature reviews or data from other populations or species, or some sources may be accurately quantified but other potentially important sources of mortality remain unquantified.
3	All primary sources identified and somewhat quantified	All primary sources of threats have been identified and have been at least somewhat quantified based on literature reviews or data from other populations or species, or some sources may be accurately quantified but other potentially important sources of mortality remain unquantified.
4	All primary sources identified and accurately quantified	All primary sources of threats have been identified and accurately quantified.
Assessment Type		
0	None	No assessment has been developed.
1	Abundance index only	A time series of abundance index has been calculated based on catch and effort data from commercial or recreational fisheries and/or research surveys.
2	Aggregated production models	Equilibrium and non-equilibrium production models aggregated both spatially and over age and size; for example, the Schaefer model and the Pella-Tomlinson, aggregated both spatially and over size and age, have been used.
3	Size/stage/age-structured models	Size, stage, or age-structured models have been developed.
4	Models with ecosystem and/or spatial and seasonal analyses	Assessment models incorporating ecosystem considerations and spatial and seasonal analyses in addition to Levels 2 or 3. Ecosystem considerations might include time-varying parameters driven by climate or environmental variables, multiple target species, or other living components of the ecosystem included as state variables in the model.
Assessment Frequency		
0	No assessment conducted	Never: no assessment conducted.
1	Most recent assessment is ≥10 years old	Most recent assessment is ≥10 years old.
2	Most recent assessment is 6-9 years old	Most recent assessment is 6-9 years old.
3	Most recent assessment is 2-5 years old	Most recent assessment is 2-5 years old.
4	Most recent is ≤ 1 year old	Assessment completed in past year.