3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Chapter 3 describes the current environment for resources that may be affected by Alternative A (No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels), Alternative B (Conduct Surveys and Mapping for Coastal and Marine Data Collection with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations), and Alternative C (Upgrades and Improvements with Greater Funding Support), and the potential environmental consequences associated with the alternatives.

Sections 3.4 through 3.13 discuss the resources analyzed and Section 3.14 discusses the resources that were considered but dismissed from further analysis. The resources analyzed and dismissed are listed below:

Resources Analyzed

- Habitats
- Marine Mammals
- Sea Turtles
- Fish
- Aquatic Macroinvertebrates
- Essential Fish Habitat
- Seabirds, Shorebirds and Coastal Birds, and Waterfowl
- Cultural and Historic Resources
- Socioeconomic Resources
- Environmental Justice

Resources Dismissed

- Air and Water Quality
- Soils and Geology
- Airborne Noise for Human Receptors
- Select Freshwater Taxa

UNDERWATER SOUND

The ambient marine and freshwater soundscape is composed of different types of sound:

1. natural biological sounds,
2. natural physical sounds, and
3. human-made sounds.

Natural biological sounds include sounds produced by fish, birds, marine mammals, invertebrates, and other animals that produce and use sound to perform various life functions. Natural physical sounds include sounds produced by the physical environment such as sounds from rain, lightning, wind, waves, the movement and breaking of ice, volcanic eruptions, earthquakes, and other physical phenomena. Human-made sounds include those from human activity such as sounds from vessel engines, oil and gas exploration (seismic airguns), drilling, construction, dredging (excavating), fishing, sonar, and echo sounders (NOAA, 2016). Since human-made sounds are relatively new to aquatic soundscapes and are considered unwanted, these sounds are interchangeably referred to as noise.

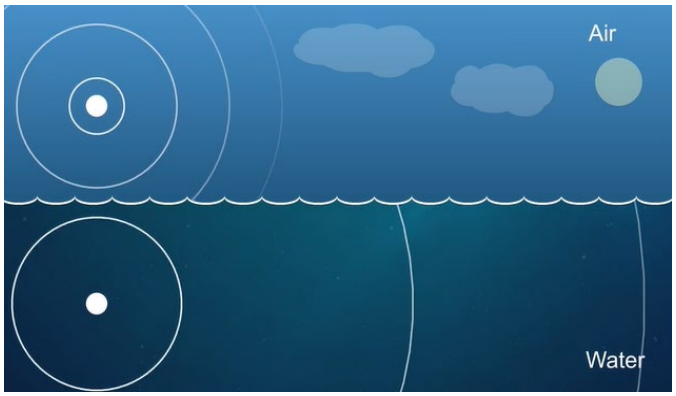
Unlike other means of communication used by animals on land involving the senses, such as visual communication and chemical communication (e.g., smell), sound propagates faster and farther underwater than in air. The properties of sound enable its production and reception to be highly efficient means of communication over the vast distances that make up the marine environment. Aquatic animals have evolved to rely on sound as a primary method for communication and for gaining information about the surrounding environment (NOAA, 2016). Therefore, understanding how to characterize and assess sound is critical to analyzing the impact of noise on aquatic animals.

Sound refers to vibrations which cause pressure changes that travel as a wave through a medium, such as air or water. In air, sounds are typically characterized by pitch and intensity. Although sounds in air and sounds in water are compared using the same metrics, the physical differences between air and water result in the same sound having different speed, pitch, and intensity.

- *Speed.* In general, sound travels much faster and farther in water than in air. Sound travels faster in denser mediums; however, the density of seawater varies with the water's salinity (salt concentration), temperature, and pressure (depth). On average, sound travels at about 1,500 meters per second (m/s) (3,500 miles per hour [mph]) in seawater compared to 340 m/s (760 mph) in air.
- *Pitch.* The pitch of a sound is the frequency, or repetition rate, of the sound wave and is measured in hertz (Hz) and kilohertz (kHz). Sound waves with higher frequencies are perceived as higher pitch sounds. The frequency of sound impacts the distance a given sound travels, in general, low frequency sounds travel farther than high frequency sounds. Some sounds, particularly low-frequency ones, can travel hundreds of kilometers underwater.
- *Intensity*. The intensity, or loudness, of a sound is represented as the amplitude of the sound wave which is the change in pressure as the sound wave passes. Sound waves with larger amplitudes are perceived as louder sounds. Intensity also depends on characteristics of the medium in which the sound is traveling. Since intensity depends on both the sound and the medium, intensity is typically measured in decibels (dB), which is a relative unit on a logarithmic scale that compares the sound pressure to a reference pressure. The reference pressure is different for different mediums. In air, decibels use a reference

pressure of 20 microPascals (µPa) such that they are scaled to the range of human hearing, so by definition, a 0 dB sound in air is the lowest limit of human hearing. Humans perceive a 10 dB increase as a doubling of loudness. In water, decibels are scaled using a reference pressure of 1 µPa. Since dB in air and dB in water use different reference pressures, sound intensity reported in dB in air is not the same as sound intensity reported in underwater dB (DOSITS, 2019).

The figure below provides a simple representation of how sound travels in air compared to water.



Source: DOSITS, 2019

Sound Traveling in Air Versus Water

The table below compares sound intensity in air to sound intensity in water for common sounds.

Intensity Comparison for Typical Airborne and Underwater Sounds

Sound	Sound Intensity in Air (dB re 20 µPa)	Sound Intensity Underwater (dB re 1 µPa)
Threshold of human hearing (1,000 Hz)	0	26*
Very quiet living room	40	66*
Normal speech (1 meter)	60	86*
Jet airliner (10 meters)	104	130*
Fin whale call (100 meters)	114*	140
Human threshold of pain (at ear drum)	140	166*
Some military artillery	160	186*
Beluga echolocation call (1 meter)	194*	220

Source: NRC, 1994

*Nominal levels after conversion to alternate medium.

The potential impact of underwater sound on receptors is related to both the characteristics of the sound received and the sensitivity of the receptor. As sound emanates from a source, the intensity of the sound decreases with distance from the source; thus, receptors located further from a source receive lower intensities of sound. Just as humans have a limited range of perceptible sound frequencies outside of which sounds are undetectable, marine animals have different ranges of perceptible sounds and rely on the use of sound for different activities. The vast majority of sounds generated by NOS activities would be outside the frequency range of human sound perception both

in air and underwater; however, some marine animals (e.g., marine mammals) can perceive and potentially be impacted by these sounds. Given the great differences between how a single sound is received and processed by different marine animal receptors, NOS determined that the impact of sound would be best assessed at the receptor level for the biological resources of marine mammals, sea turtles, fish, aquatic macroinvertebrates, and birds.

3.1 Affected Environment Methodology

The affected environment summarizes the current physical, biological, social, and economic environments of the "action area," which includes rivers; states' offshore waters; the United States (U.S.) territorial sea; the contiguous zone; the U.S. Exclusive Economic Zone (U.S. EEZ); and coastal and riparian lands for projects such as the installation, maintenance, and removal of tide gauges. This includes the U.S. portions of the Great Lakes and internal waters including Lakes Tahoe, Mead, Champlain, Okeechobee, and major rivers such as the Mississippi, Missouri, Hudson, and Columbia rivers. For each resource, the affected environment describes the elements or components of the resource that may be potentially affected by the alternatives.

3.2 Environmental Consequences Methodology

The environmental consequences analysis considers how the condition of a resource would change as a result of implementing each of the alternatives and describes the impacts in terms of types (direct, indirect, cumulative, beneficial, adverse), context, intensity, and significance. The types of impacts are defined in Section 3.2.1 and the development of significance criteria is described in Section 3.2.2 below. The impacts analysis is performed using a framework that follows a logical sequence of analytical steps for each resource under each alternative:

- **Impact Causing Factors.** Evaluate proposed activities to identify which elements of the activities could lead to impacts - the impact causing factors. A systematic consideration of causes and effects is used to derive the impact causing factors from known actions and characteristics that define the activities.
- **Detailed Analysis of Impacts.** Evaluate the impact causing factors to produce a detailed analysis of the impacts. Assess the context and intensity of the impacts from each impact causing factor, then evaluate the impacts from all impact causing factors to define significance for the alternative.
- **Significance Criteria.** Develop and apply criteria that are standards for evaluating the significance of the impacts caused by the proposed activities.

3.2.1 Types of Impacts

According to the Council on Environmental Quality's (CEQ) National Environmental Policy Act (NEPA) Regulations at 40 Code of Federal Regulations (CFR) 1500-1508 (1978), direct and indirect effects are defined as:

Direct effects: Effects that are caused by the action and occur at the same time and place (1508.8(a)).

Indirect effects: Effects that are caused by the action and occur later in time or are farther removed in distance but are still reasonably foreseeable. Indirect effects also include "induced changes" in the human and natural environments (1508.8(b)).