Professor Tanya Goetz, New York City College of Technology

Source: commons.wikimedia.org

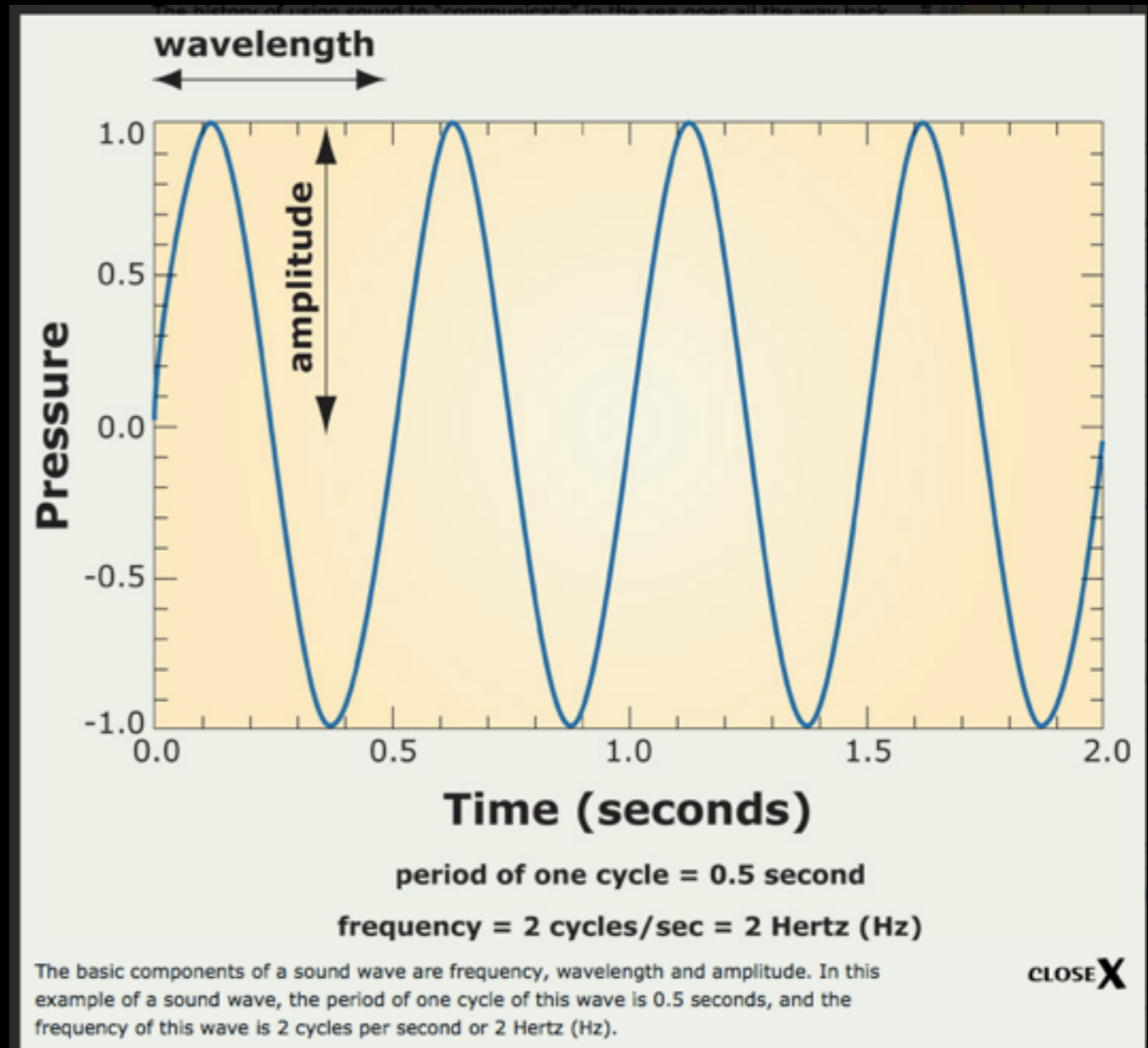# What You Should Know About Audio

The Physics of Sound: Mechanical Waves

Sound Wave Fast Facts

- sensory experience AND an analog phenomenon

- a wave generated by vibrating objects in a medium such as air. Sound is considered a mechanical wave—it doesn't operate in a vacuum.

- your vocal cords, a guitar string all cause disturbance in the air molecules, causing changes in air pressure that form a sound wave
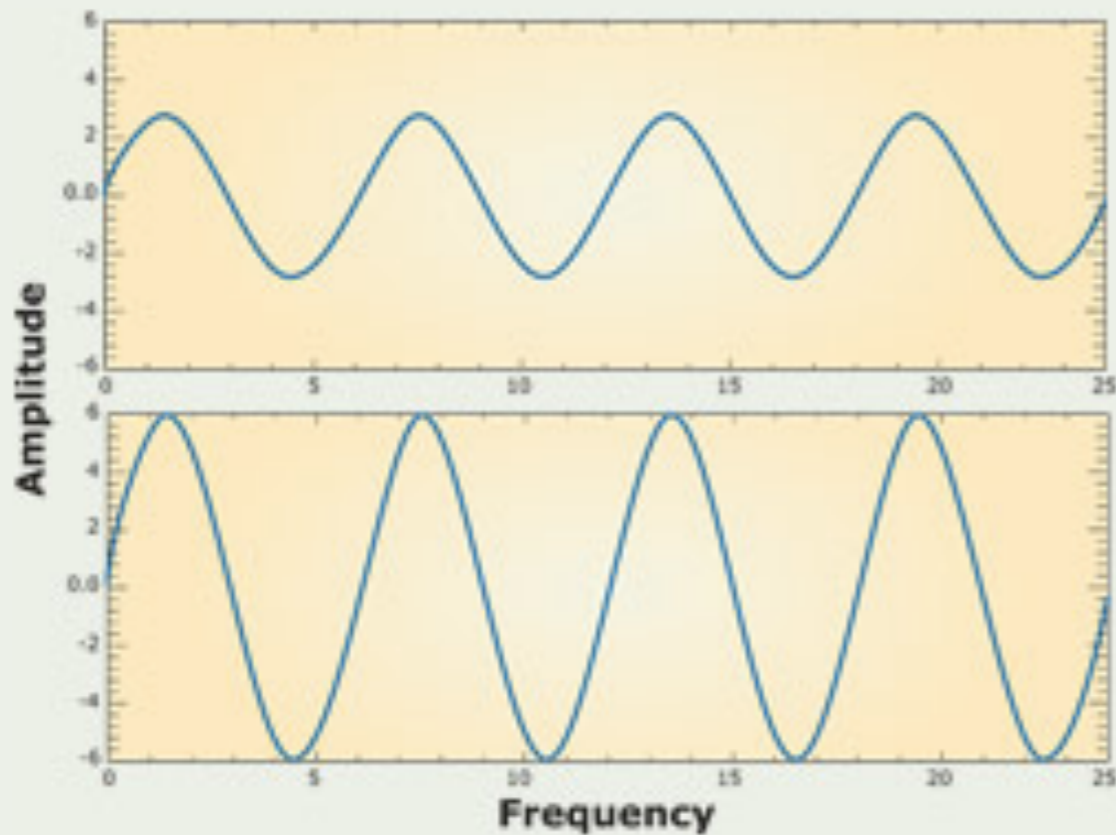
3 characteristics of sound waves

- Wavelength: the distance between the two peaks of the sound wave

- Frequency: # of completed waves per unit of time. Measured in Hertz where unit of time is 1 second. 1 Hz = 1 cycle/second.

- Amplitude: the height of the "bump" or the "loudness" of the sound

wavelength

Pressure

amplitude

Time (seconds)

period of one cycle = 0.5 second

frequency = 2 cycles/sec = 2 Hertz (Hz)

The basic components of a sound wave are frequency, wavelength and amplitude. In this example of a sound wave, the period of one cycle of this wave is 0.5 seconds, and the frequency of this wave is 2 cycles per second or 2 Hertz (Hz).
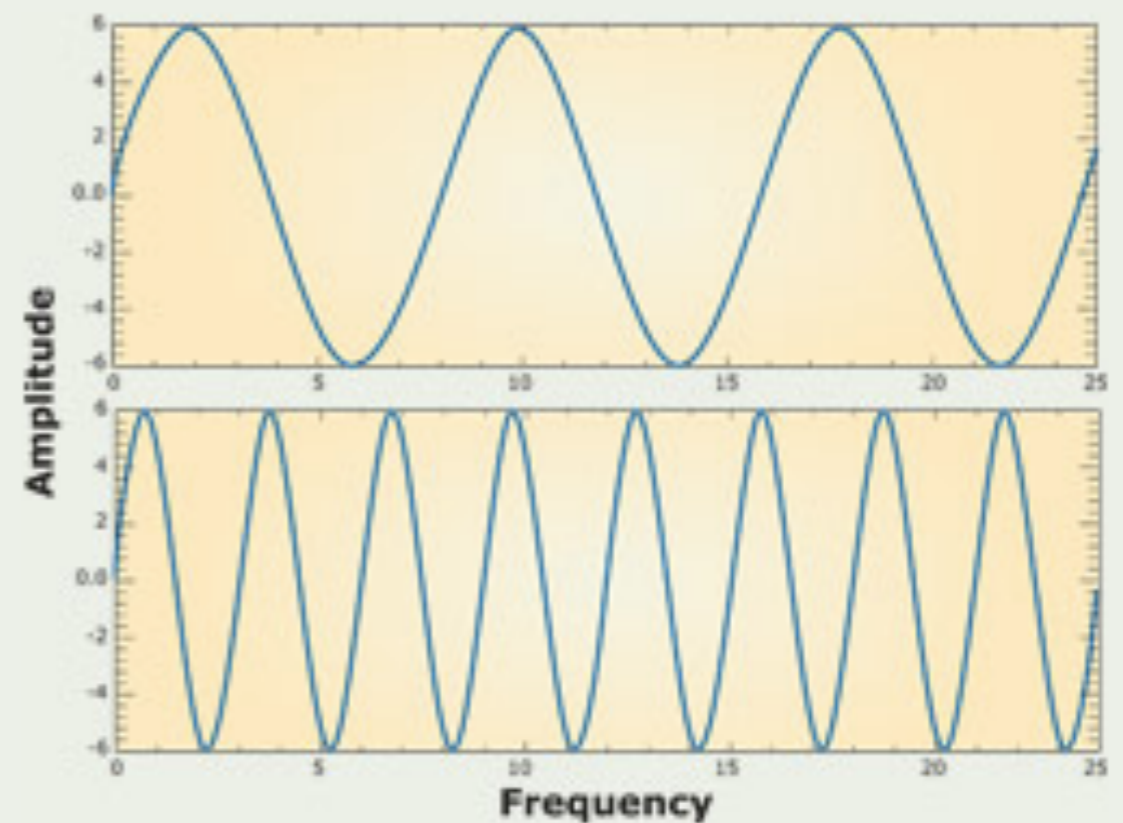
CLOSE X

Source: www.divediscover.whoi.edu/

Images showing Amplitude vs. Frequency

These two waves have the same frequency but different amplitudes.

These two waves have the same amplitude but different frequencies.

Sound frequency and the pitch of a sound are linked. Higher frequencies = higher pitches. Human ear hears song ranging from 20 Hz to 20,000 Hz.

Loudness Vs. Sound Intensity

- Like color, the loudness of a sound is a subjective perception and factors such as the age of the listener affects the subjective perception of sound.

- To measure loudness, a 1,000 Hz tone is used as a benchmark tone. The volume of this reference is adjusted until it is perceived as being as loud as the sound being measured.

- Sound intensity, on the other hand, can be measured objectively by auditory devices with no need for a listener. Sound intensity is measured in decibels. The threshold of pain is 120 decibels.

- Often, the higher the sound intensity the louder the sound is to the listener but not always.

Decibel Chart of Everyday Sound

Decibels	Example Sources	Health effects
	Decibel Levels of Common Noise Sources[1]	
0	Silence	None
10	Breathing	None
20	Whispering	None
30	Quiet rural background noise	None
40	Library noises, quiet urban background noise	None
50	Relaxed conversation, ordinary suburban activity	None
60	Busy office or restaurant noise, loud conversation	None
70	TV volume, Freeway traffic at 50 feet (15.2 meters)	None; unpleasant for some
80	Factory noise, food processor, car wash at 20 feet (6.1 meters)	Possible hearing damage after lengthy exposure
90	Lawn mower, motorcycle at 25 feet (7.62 meters)	Likely hearing damage after lengthy exposure
100	Outboard motor, jackhammer	Serious damage likely after lengthy exposure
110	Loud rock concert, steel mill	May be immediately painful; damage after lengthy exposure very likely
120	Chainsaw, thunderclap	Usually immediately painful
130-150	Jet takeoffs on aircraft carrier deck	Immediate hearing loss or eardrum rupture possible

http://www.wikihow.com/Measure-Decibels

Devices for Measuring Sound

Decibel 10th app for free for measuring sound and at B & H, the professional version from Bogen communications for $159.

From Analog to Digital Sound

- Sampling : The higher the sampling rate, the better the sound fidelity to the original BUT the more storage space and processing time for the file.

- Quantizing: the samples of amplitude values are taken and rounded to the nearest value on a scale of levels. The number of levels is expressed as bit depth. 8 bit audio has 256 possible levels.

- Dynamic Range: in audio, refers to range between the lowest and highest value in the scale used for digitizing the sound.

- As with images, there is always a trade-off between quality and file size which impacts storage and download time—with the latter being more of a problem.

- File Size = duration X sampling rate X bit depth X # of channels

Digital Audio Formats

There are numerous *audio file formats* for storing audio on a computer.

- **WAV** format is widely used on Windows and is needed for creating an audio CD.
- **AIFF** is widely used on Apple's operating systems.
- Compressed formats are used on portable music players.

Term	Description
AAC:	A *lossy*, *size-compressed* audio codec and its reference audio codec implementation. AAC files usually have M4A *extension*, with variants such as M4P (protected) and M4R (ringtones). Usually gives better quality for the same *bit rate* than the older *MP3* format. Is default audio format for iTunes®, iPod® and iPhone®, and Sony PlayStation 3.
AIFF:	A *container* format, almost always used for *lossless*, *uncompressed*, *PCM* audio with similar file size to *WAV*. Although the classic AIFF format is in Apple's earlier *Big-endian* byte order, Mac OS X has always written "AIFF-C/sowt" files. These have the same AIFF extension as classic AIFF and are identical to it except for being *Little-endian* like WAV format. Rarely, files with AIFC extension can contain *compressed* formats.
Apple Lossless:	Also known as Apple Lossless Audio Codec (ALAC) or Apple Lossless Encoder (ALE), this is a *lossless*, *size-compressed* codec usually stored within an MP4 *container format* with M4A *extension*. ALAC is Apple's equivalent of *FLAC* (which is not officially supported by Apple).
AU:	A *container* format, used by Audacity for storage of *lossless*, *uncompressed*, *PCM* audio data. Not be confused with *Sun/NeXT AU* files, which are usually U-Law encoded PCM files but may be headerless.
FLAC:	An Open Source *lossless*, *size-compressed* audio format
GSM 6.10:	Global System for Mobile communications is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe protocols for second-generation (2G) digital cellular networks used by mobile phones. As of 2014 it has become the default global standard for mobile communications - with over 90% market share, operating in over 219 countries and territories.
MIDI:	MIDI is a small-sized file format which stores how to play notes, widely used for keyboard instruments. It is not an audio file format like *WAV* that uses thousands of *samples* to record the full sound of the notes actually being played.
MP2:	A *lossy*, *size-compressed* audio format mainly used by the broadcast media
MP3:	A *lossy*, *size-compressed* audio format which is the main format for transmitting audio over the internet
Ogg Vorbis:	An Open Source *lossy*, *size-compressed* audio format, strictly speaking the *Vorbis* format in a *container* having **OGG** *extension*.
WAV:	A *container* format, almost always used for *lossless*, *uncompressed*, *PCM* audio. The format is in Microsoft's *Little-Endian* byte order.
WMA:	A *container* format. Windows Media Audio is a *lossy*, *size-compressed* audio format developed by Microsoft. It is a proprietary technology that forms part of the Windows Media framework. WMA consists of four distinct codecs. The original WMA codec, known simply as WMA, was conceived as a competitor to the popular *MP3* and RealAudio codecs.

Strategies for Reducing File Size

- Reduce the # of channels

- Reducing the sampling rate: as with reducing the sampling rate with images, this reduces the quality of the sound. Human ear is most sensitive to 2,000 to 5,000 Hz. Nyqvist's theorem need two points in each sound wave cycle for fidelity to original sound wave. This is called Nyqvist rate and the formula is sampling rate must be 2X the audio frequency.

- Reducing the Bit depth

- Applying File Compression

- Shorten the Duration of the audio IF the intended use allows for this. Unlike static image files. with audio files one has the extra

But Consider Carefully:

- the target audience for your audio—what equipment do they have? Will they be listening on a computer, a phone? What is their internet connection like? What is their age?

- The file size limits. Is the file being streamed used on the web?

- Keeping the file as a source file in case you need to make edits later

- Common Sampling Rates: 11.025 Hz Am radio Quality. 22.050 Hz FM radio quality (multimedia projects), 44,100 Hz, CD quality, 48,000 Hz DAT quality, 96,000 Hz and 192,000 Hz DVD audio quality

Digital Audio Editors

- Garageband

- Audacity (Free)

- Adobe Audition

- Sony Sound Forge

- http://www.techradar.com/us/news/software/applications/best-free-audio-editing-software-9-programs-we-recommend-1136943
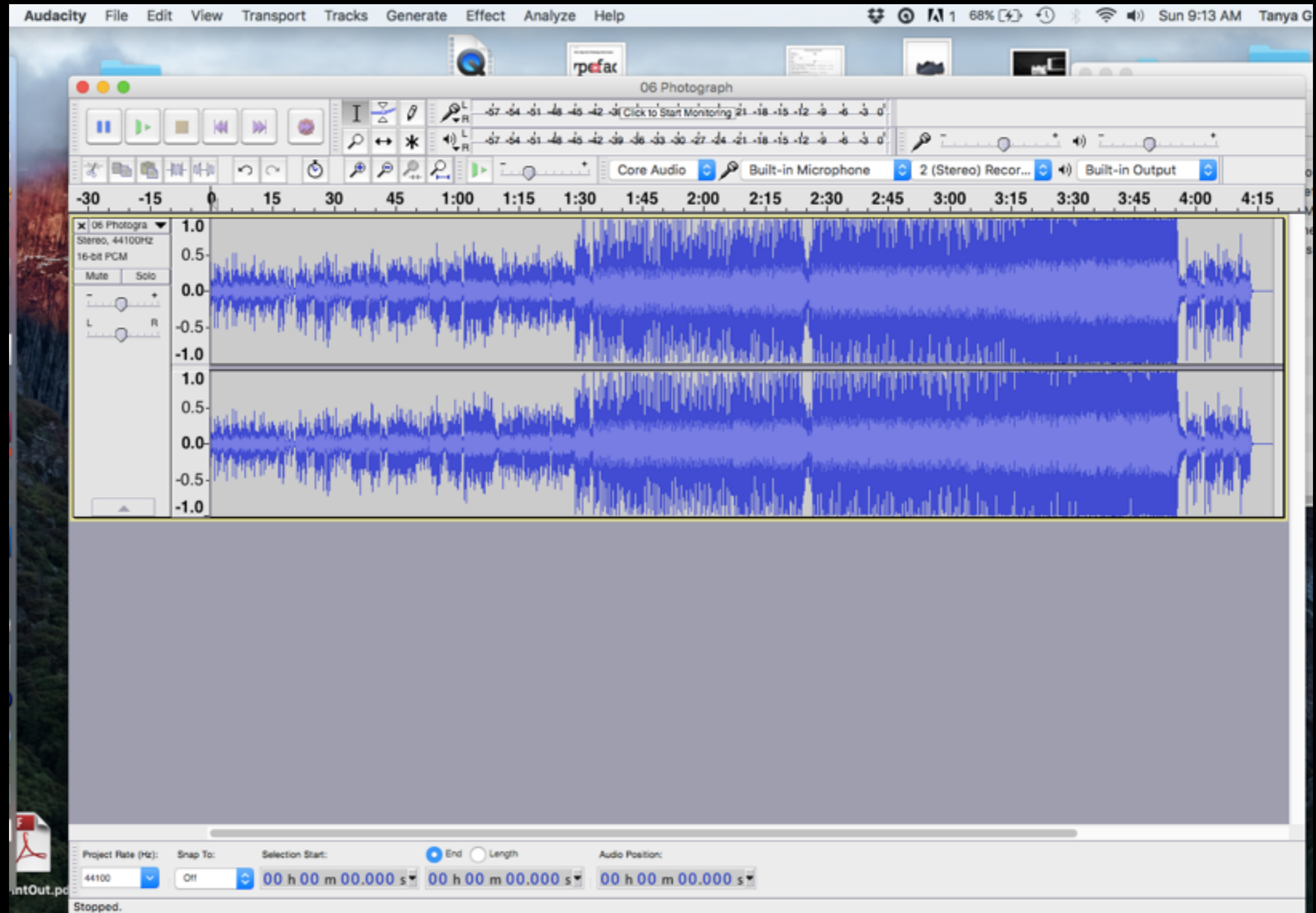
Digital Audio Editing vs. Image Editing

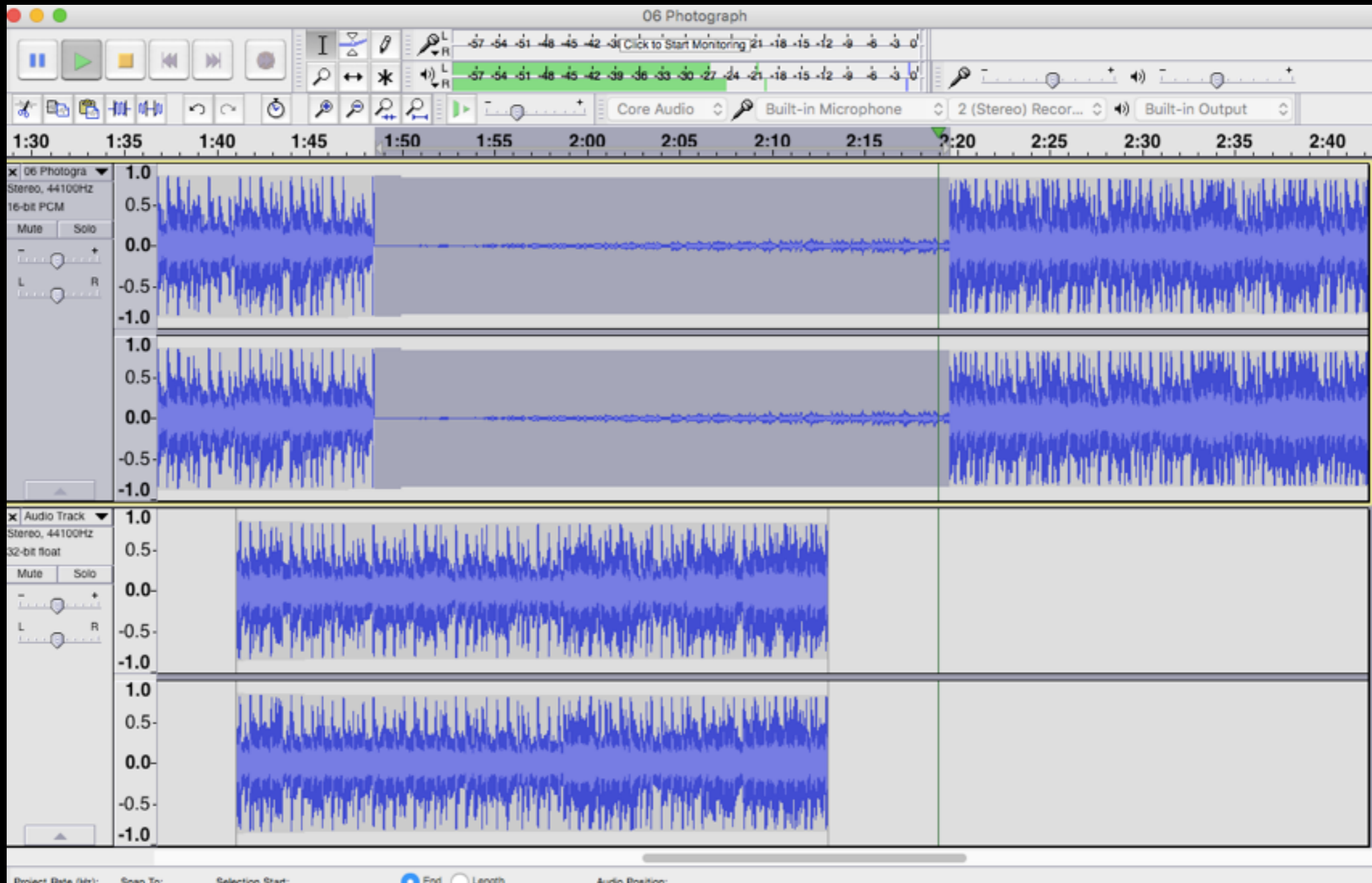| TABLE 5.1	Parallels between Basic Digital Image and Digital Audio Editing
Basic Digital Image Editing	**Basic Digital Audio Editing**
Reassemble image content by cutting, copying, and pasting	Reassemble an audio waveform by cutting, copying, and pasting
Clean up dirt, dust, and scratches	Noise reduction
Adjust tonal value	Adjust volume
Resize the image	Resample the audio
Reduce the image's color depth	Reduce the audio's bit depth
Apply filters for special effects	Apply filters for special effects, such as reverb and pitch changes
If you want to save your file as JPEG for the Web, wait until the last step because JPEG uses lossy compression	If you want to save your file as MP3 for the Web, wait until the last step because MP3 uses lossy compression

"Photograph": Before

"Photograph": After

GarageBand Workspace