

The Impacts of Shipping Noise on Cetaceans, Fish, Invertebrates, and Ecosystems



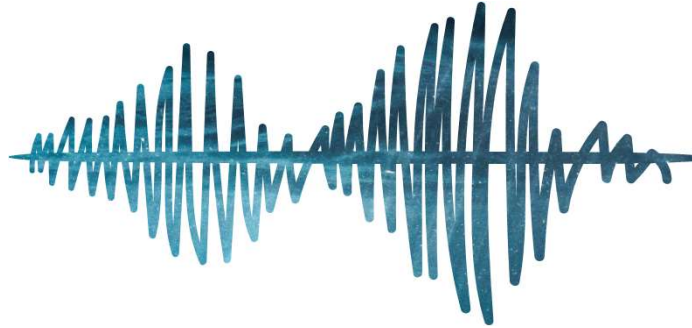
Nicolas Entrup, OceanCare

Russell Leaper, IFAW

Lindy Weilgart, Ph.D., OceanCare & Dalhousie University



Various Responses of Marine Life to Shipping Noise



- Poor body condition
- Lower growth rates
- Greater vulnerability to predation
- Stress
- Masking
- Change in vocalizations
- Lower reproduction
- Higher metabolic rates
- Decreased or unsuccessful feeding/foraging
- Uncoordinated schooling
- Hearing loss

Human-Caused Ocean Noise

Can prevent whales from:

- hearing prey or predators
- orienting, sensing the environment
- communicating with mates, group members, or young

→ **Loss in whale communication range**



Before Noise

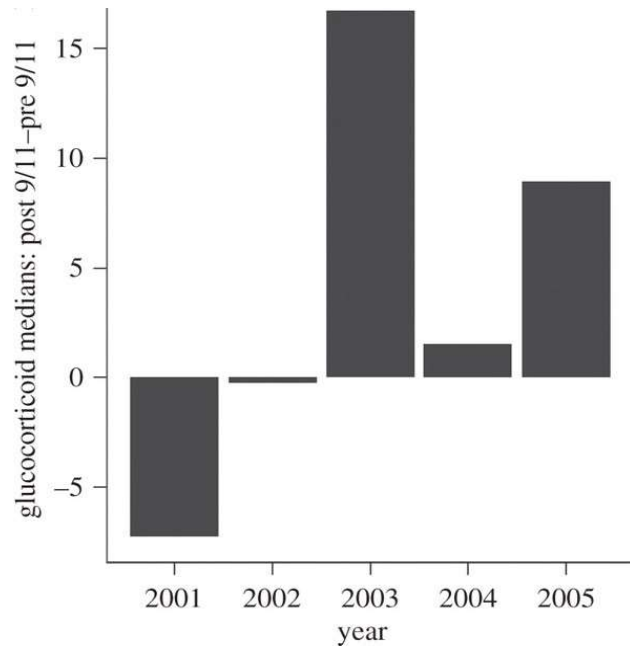
MASKING



After Noise

From C.W. Clark

Right Whales Stressed from Ship Noise



Yearly difference in stress hormone levels post 9/11, associated with less underwater low-frequency noise resulting from less ship traffic

(Rolland et al. 2012)

Cetacean Responses to Shipping Noise

- Gray whales increased their vocalization rate (*Dahlheim & Castellote 2016*)
- Humpback calls became louder (*Frankel and Gabriele 2017, Fournet et al. 2018*)
- Blainville's beaked whales decreased their foraging movement up to at least 5.2 km away from vessel (*Pirodda et al. 2012*)
- Shipping noise lowers killer whale foraging success due to masking. No successful prey capture when noise >111 dB re 1 μ Pa (15–45 kHz band) (*Tennessen et al. 2024*)
- Ship noise reduced foraging efficiency by > 50%, communication range reduction to 1/5 in Cuvier's beaked whales (*Aguilar Soto et al. 2006*)



Fish Responses to Shipping Noise

- Tuna schooling lost aggregated structure, became uncoordinated, aggressive
Can affect homing accuracy of migration to spawning and feeding grounds (Sara et al. 2007)
- Sea bream moved more, showed stress and intense metabolic activity, with less energy for feeding, migration, reproduction
(Buscaino et al. 2010, Celi et al. 2016)
- Stress hormone cortisol increased 81%-120% in fish species with shipping noise playback
(Wysocki et al. 2006)
- Reduced growth rates and caused poorer body condition in larval Atlantic cod
(Nedelec et al. 2015)
- Lowered the call rate in oyster toadfish
(Colbert et al. 2023)
- Catch records of three identical trawlers showed the noisiest boat caught less saithe
(Engås & Løkkeborg 2002)



Invertebrate Responses to Shipping Noise

- In the sea slug, the stress of low-frequency noise increased inflammation (*Sun and Andersson 2002, Rao, 2001*), which could have caused damage to the Central Nervous System (*Williams and O'Neill 2018, Tu et al. 2021*)
- Harbor traffic noise interfered with zooplankton feeding rates (*Kühn et al. 2023*)
- Shore crab feeding was interrupted, and they were at increased risk of predation with just 7.5 mins. of ship noise (148-155 dB_{rms} re 1 μPa) (*Wale et al. 2013*)



Shipping Noise Impacts on Ecosystems and Ecological Services

- 6 hrs of ship noise caused breaks in DNA of blue mussel, lower filtration (algal clearance), lower oxygen consumption (*Wale et al. 2016, 2019*)
 - ▶ Mussels could not perform important ecological service of water filtration
- Various marine organisms showed genetic changes in oxidative stress, metabolism, and immune response, and physiological changes including in blood chemistry, and metabolic and neurological responses (*El Dairi et al. 2024*)
- An amphipod crustacean showed lower bottom sediment-mixing rates with shipping noise, while a bivalve showed a potential stress response (*Wang et al. 2022*)
 - ▶ Benthic macroinvertebrates provide crucial ecosystem-maintaining services, which, if interfered with, could impair biogeochemical cycling

Shipping Noise Impacts on Ecosystems and Ecological Services

- Ship noise suppressed oyster activity, decreasing food uptake, causing slower growth rate, greater oxidative stress (*Charifi et al. 2018*)
 - ▶ The slowdown in growth constitutes “a potentially massive risk in terms of ecosystem productivity”



Noise Impacts on Ecosystems & Ecological Services

- Noise repressed burying and bio-irrigation behavior (or water circulation within lobster burrows) in Norway lobsters (*Solan et al. 2016*)
- Manila clams showed a stress response to noise, individuals relocated less, stayed on top of the seabed, and closed their valves, increasing lactate dangerously
 - ▶ Clams could not mix upper layers of sediment and could not feed
 - ▶ Noise changed the fluid and particle transport that invertebrates provide, key to nutrient cycling on the seabed



Summary



- Impacts of shipping noise on cetaceans, fish, and invertebrates include: masking, stress, lower reproduction, less feeding, changes in vocalizations, and greater vulnerability to predation.
- Ecological services are compromised by shipping noise such as: water filtration, bio-irrigation, sediment mixing, nutrient cycling, and biogeochemical cycling which can affect ecosystem productivity.
- Impacts include socio-economic consequences, such as decreased fisheries catch rates



Core Aspects: Food for Thought

- URN reduction at source
- Prioritize measures generating multi-environmental benefits
- Cost-Effectiveness
- Incentive Programmes

Nicolas Entrup
OceanCare

nentrup@oceancare.org

Russell Leaper
IFAW

russell@rcleaper.com

Lindy Weilgart, Ph.D.
OceanCare &
Dalhousie University

linda.weilgart@dal.ca

