Influence of vessel noise and light regime on finless porpoise (*Neophocaena asiaeorientalis*) echolocation characteristics in Seto Inland Sea and Mikawa Bay, Japan

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Summary

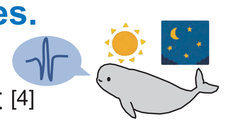
- The effects of vessel noise and day/night on the echolocation characteristics of the finless porpoises at Japanese coastal areas were clarified.
- This study found that the echolocation characteristics of finless porpoises were more affected by light regime (day/night) than by absence/presence vessel noise.The apparent source levels of echolocation clicks were decreased during the night in presence of vessel noise.
- During the night, -3 dB bandwidth was wider, the click duration was shorter, and inter-click intervals were shorter. These changes may help the finless porpoises gain more information to compensate for the lack of visual information.
- **The impact assessments of noise on echolocation characteristics should take into account day/night parameters.**

Introduction

Vocalization changes by vessel noise

- Atlantic bottlenose dolphin and harbor porpoise decreased emitting buzz rate [1,2]
- Lahille's bottlenose dolphin emitted significantly fewer echolocation clicks [3]
- Melon-headed whale increased the echolocation source level [4]

Few studies have examined whether the characteristics of echolocation clicks were altered by vessel noises.



Vocalization changes by light regime (day or night)

- Melon-headed whales emitted higher center frequencies at night [4]
- Harbor porpoise emitted high proportion of click trains with short inter-click intervals (ICI) at night [5]

Light regime might effect on echolocation characteristics.

Target species

Narrow-ridged finless porpoise *Neophocaena asiaeorientalis*

- They often observed in shallow areas (<50 m depth)[6], exposing them to anthropogenic activities and impacts

Objective

To examine the effects of vessel noise, light regime, and environmental factors on the echolocation characteristics of finless porpoises.

Materials & Methods

Study area (Fig.1), period, and devices

Date : June - September, 2021
March - August, 2022
Duration: St. S : 1103 hours,
St. M : 1528.5 hours
Devices (Fig. 2):
SoundTrap 300 HF (Ocean Instruments)
- sampling frequency : 576 kHz

A-tag (ML 200-AS8, MMT)
- stereo event recorder of pulse informations

INFINITY-EM (JFE Advantech)
- recording the water temperature and synthetic flow velocity

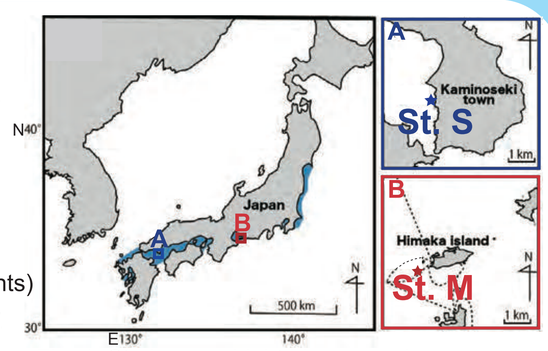


Fig. 1 Study area. Light blue area shows distribution of finless porpoise in the Japanese coastal areas [7].

Signal analysed & statistical analyses

- On-axis echolocation clicks were analysed
- Best model using GLM or GLMM were determined

Response variables
aparent source level (ASL), center frequency, -3dB bandwidth(BW), click duration, or ICI

Explanatory variables
absence/presence vessel noise (as a factor), day/night (factor type), water temperature, synthetic flow velocity, and noise level (rms level)

Random variable
areas (factor type)

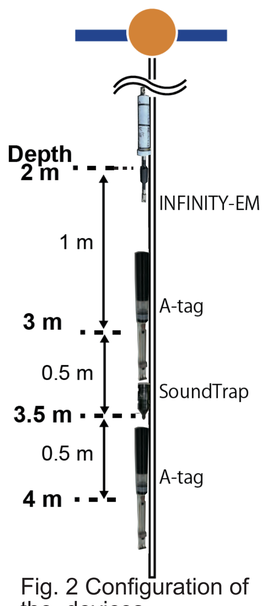


Fig. 2 Configuration of the devices.

Results

Table 1 Best model of GLM or GLMM.
Vessel:absence/presence vessel noise, DN:day/night, Temp:temperature, *:interaction between explanatory variables

ASL	~	Vessel+DN+Vessel*DN+Temp (GLMM)
center frequency	~	Vessel+DN+Temp+noise level (GLM)
-3dB BW	~	Vessel+DN+Vessel*DN+Temp+noise level (GLMM)
click duration	~	Vessel+DN+Vessel*DN+noise level (GLMM)
ICI	~	DN+noise level (GLM)

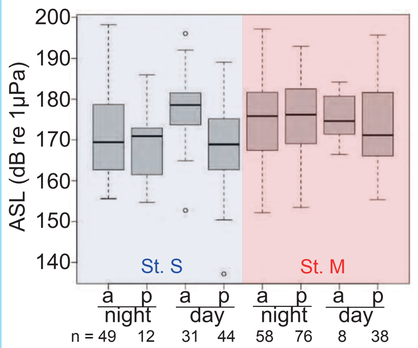


Fig. 3 Boxplot of **ASL**.
a:absence vessel noise, p:presence vessel noise. At St. S, the ASL was higher during the day with no vessel noise (p<0.01).

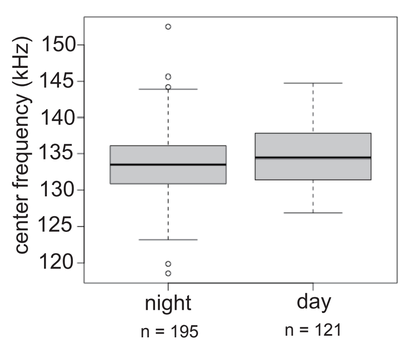


Fig. 4 Box plot of **center frequency**.
The center frequency was not significantly affected by day/night (p=0.10).

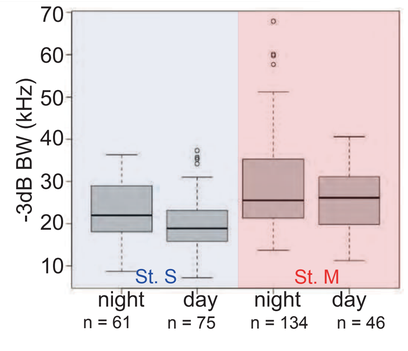


Fig. 5 Box plot of **-3dB BW**.
The -3dB BW was wider at night (p<0.01)

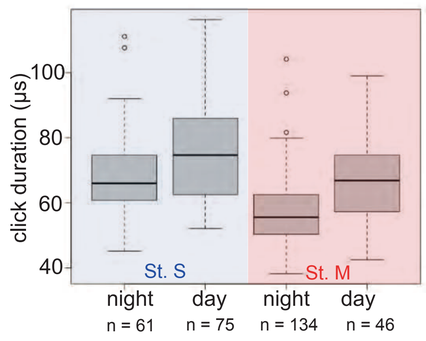


Fig. 6 Box plot of **click duration**.
The click duration was shorter at night (p<0.10).

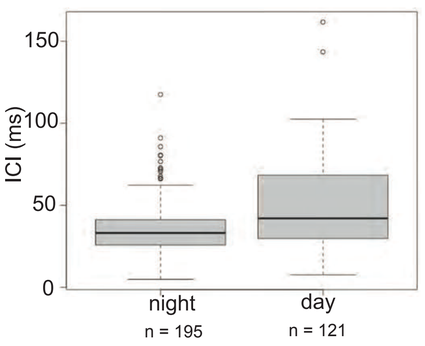
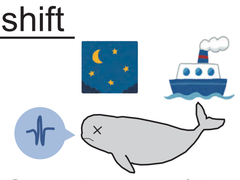


Fig. 7 Box plot of **ICI.**
The ICI was shorter at night (p<0.10).

Discussion

ASL shift



Small voice (Fig. 3)

Vigilance response for vessel noise

- Bottlenose dolphin and humpback dolphin decrease emitting echolocation clicks due to acoustic interference and enhanced vigilance in the prensece of vessels [8,9]

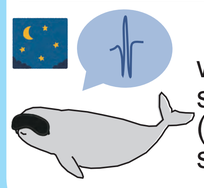
Center frequency shift

No shift
(Fig. 4)

Difficulty of frequency fluctuation because of high frequency

- Melon-headed whale change the center frequency (broad-band click, 25-30 kHz[10]) at night [4]
- Finless porpoise emitted narrow-band high frequency click (110 - 150 kHz)

-3dB BW, click duration ICI shifts



wider bandwidths (Fig. 5)
shorter click duration (Fig. 6)
shorter ICI (Fig. 7)

More information from the clicks

- Wider bandwidths provide more information
- Shorter click duration, the higher the accuracy of binaural time measurements, resulting improved localization ability
- Shorter ICI indicated finless porpoise were searching more per time

Acknowledgements

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