Relationship between Roar Sound and Behavior of Steller Sea Lion *Eumetopias jubatus* Migrating to the West Coast of Hokkaido, Northern Japan.

Tae-Geon Park, Kohji Iida and Haruo Ogi
Introduction

Steller sea lions’ breeding area & migrating route To Japan

• Migrating Route
  Kamchatka Peninsula & Kuril Islands
  → Western coast of Hokkaido of Japan

• Inhabitation Period
  November to April next year

Principal role of roar sound on the maintenance of the navigation and the crowd in the long distance migrating

• Objectives
  ➢ Roar sound characteristics relative to their behavior
**Methods & Materials**

**Apparatus for measurement of Steller sea lions at wild state**

**In habitat**

- Video camera & Monitor: Real Time view of Steller sea lions’ behavior at wild state
- Microphone: Recording their Roar sound
- Recording time: April 12 ~ 16, 2003, a daytime

![Image of Inhabitat with 42-66 individual inhabitants, video camera, and microphone](image_url)

- Video camera & Monitor: Real Time view of Steller sea lions’ behavior at wild state
- Microphone: Recording their Roar sound
- Recording time: April 12 ~ 16, 2003, a daytime
Apparatus for measurement of Steller sea lions at aquarium

In Aquarium

Observer Shelter

Video Camera

Video Camera

Monitor and Video Recorder

- Captive 3 individuals: male (23 year), female (18 year), juvenile (3 year)
- Video camera: behavior view of Steller sea lions with recording their Roar sound
- Recording time: November 1 ~ 30, 2001, continuous 24 hours
Roar sound Classification by Steller sea lion's behavior

Roar sound characteristic analysis

Digital Sonagraph
KAY DSP Sona-Graph 5500

Captive male  Wheedling

Captive female  Acknowledge

Communication  Wild male

Threat  Wild male
Results & Discussions

Diurnal Variation of Roar sound by Steller sea lion

Wild Steller sea lion

- Averaged period: 2 days
- Max. Frequency time: 1 hour after sunrise & 2 hours before sunset

Captive Steller sea lion

- Averaged period: 15 days
- Max. Frequency time: 2 hour after sunrise & 1 hours before sunset
Variation of Roar sound frequency by Sex for Steller sea lion

→ Female roar frequency is relatively higher than that of male

• Ratio of roar sound Frequency by sex

➤ Wild individuals
  Female : male = 3.6 : 1

➤ Captive individuals
  Female : male = 1.3 : 1

• Comparison of roar sound frequency by live condition

No difference between wild male sea lion and captive male.

➤ Frequency of wild female is higher than captive female.
  Because competition rate in natural condition is high.
Comparison of Formant Frequency between male & female for Wild & Captive Steller sea lion

Formant Frequency

<table>
<thead>
<tr>
<th>Roar sound classifications</th>
<th>wild Steller sea lion</th>
<th>captive Steller sea lion</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>male</td>
<td>female</td>
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<tr>
<td>communication</td>
<td>263 Hz</td>
<td>353 Hz</td>
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<tr>
<td>wheedling</td>
<td>280 Hz</td>
<td>325 Hz</td>
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<td>threat</td>
<td>291 Hz</td>
<td>297 Hz</td>
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Comparison of Sound Duration between male & female for Wild & Captive Steller sea lion

**Communication**
- Wild male: 0.9 sec.
- Wild female: 0.7 sec.
- Captive male: 1.6 sec.
- Captive female: 1.8 sec.

**Wheedling**
- Wild male: 0.6 sec.
- Wild female: 0.5 sec.
- Captive male: 1.6 sec.
- Captive female: -

**Threat**
- Wild male: 0.6 sec.
- Wild female: 0.4 sec.
- Captive male: -
- Captive female: 1.0 sec.

**Acknowledge**
- Wild male: -
- Wild female: -
- Captive male: 1.1 sec.
Pitch Pattern Distributions of Communication sound for Steller sea lion

<table>
<thead>
<tr>
<th>Order of utilization</th>
<th>Wild male</th>
<th>Wild female</th>
<th>Captive male</th>
<th>Captive female</th>
<th>Captive juvenile</th>
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✿: All Steller sea lions  ◎: Only four Steller sea lions
○: Only three Steller sea lions  △: Only two Steller sea lions

- Wild male: 17  · captive male: 10
- Wild female: 13  · captive female: 15
- Captive juvenile: 6

Prominent pattern: long flat sound
Pitch Pattern Distributions of Wheedling sound for Steller sea lion

Wild male

Wild female

Captive male

Order of utilization

Wild male

Wild female

Captive male

Order of utilization

1
2
3
4
5
6
7
8
9
10
11
12

• wild male : 12 • captive male : 12
• wild female : 12

Used pitch pattern type

Prominent pattern

• wild animal : short ascending sound
• captive animal : short waveform sound

☆: All Steller sea lions
◎: Only two Steller sea lions

Frequency (%)
**Pitch Pattern Distributions of Threat sound for Steller sea lion**

<table>
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- 🌟: All Steller sea lions
- 🌟: Only two Steller sea lions

**Used pitch pattern type**
- wild male: 7
- captive female: 8
- wild female: 12

**Prominent pattern**
- short descending sound
Pitch Pattern Frequency relative to pattern types of Communication sound for Steller sea lion

Order of utilization

Pitch pattern frequency (‰)

Wild male
N=80

Wild female
N=61

Captive male
N=25

Captive female
N=47

Captive pup
N=15

N=80 N=61 N=25 N=47 N=15
Summary

Analyzed roar sound characteristic of Steller Sea Lion *Eumetopias jubatus* at habitat of the west coast of Hokkaido and at aquarium using Visual and Acoustical View.

• Prominent roar sound characteristic classification by their behavior
  communication sound, wheedling sound, threat sound and the acknowledgment sound

• Ratio of roar sound frequency
  Their female roar 3.6 and 1.3 times as male as do in wild and captive Steller sea lion, respectively.

• Roar sound frequency characteristic by classification
  averaged Formant frequency relative to classified behavior
  
  Wild Steller sea lion ; 263 Hz(male) / 353 Hz(female)  
  Captive Steller sea lion; 372 Hz(male) / 469 Hz(female)  

• Characteristic by Pitch pattern of roar sound
  Not simple crying but mutual communication