Aggregation habitat variation of pacific saury and its influence factors based on HSI model

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1. Introduction
2. Material and methods
3. Results
4. Discussion
5. Summary
1. INTRODUCTION

There are about 60 China’s PS fishing vessels operated in the NWP.

The fishing area mainly distributed outside of Japan/Russia’s EEZ.

Main fishing season: June to November
1. INTRODUCTION


(Chang, et al, 2018)
1. INTRODUCTION

HSI Model → Annual HSI/PA

Climate-Ocean indices → Annual Total Catch

( PA: potential suitable habitat area )
1. Introduction
2. Material and methods
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2. MATERIAL AND METHODS

HSI Model

- Fishing Data
- Yield-Density Model (SI) (Reciprocal of binomial)
- Weighted arithmetic mean model (WAMM)

\[ SI_{v,i} = \frac{Effort_i}{Effort_{max}} \]

\[ y = \frac{1}{(a + bx + cx^2)} \]

\[ HSI = SI_{sst} \cdot W_{sst} + SI_{sstg} \cdot W_{sstg} \]

(Hua, et al, online)
2. MATERIAL AND METHODS

- Fishing Data

\[ SI_{v,i} = \frac{Effort_i}{Effort_{max}} \]
2. MATERIAL AND METHODS

Potential suitable habitat area (km²) \((PA)\)  
\[ \text{HSI} \geq 0.6 \]  
WGS84

(Ito, et al, 2007)
2. MATERIAL AND METHODS

Annual Total Catch

Annual Total Catch (NPFC website, 2018)
2. MATERIAL AND METHODS

- Fishing Data
- Yield-Density Model (SI)
- Weighted arithmetic mean model (WAMM)
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3. RESULTS

**HSI Model**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>Opt</th>
<th>95% CI</th>
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<tbody>
<tr>
<td>SST</td>
<td>°C</td>
<td>14.05</td>
<td>14.02</td>
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<tr>
<td>SSTG</td>
<td>°C/km</td>
<td>0.0179</td>
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</table>

\[
HSI = \hat{SI}_{sst} \cdot 41.10\% + \hat{SI}_{sstg} \cdot 58.90\%
\]
3. RESULTS

Monthly distribution of HSI

- In Winter and Spring, High HSI (HSI≥0.6) area, distributed in MW, southern 40°N
- In main fishing season: northern ward in Jun-Aug Southern ward Sep-Nov northern 40 °N
3. RESULTS

- In 2016, the value of annual FA/PA was significantly lower than other years.
3. RESULTS

- In latitude direction, the value of annual HSI value in 2016 is significantly lower than other years.
### 3. RESULTS

The relationship between yearly HSI/PA and climate-ocean indices

<table>
<thead>
<tr>
<th></th>
<th>Nino 3.4</th>
<th>NPI</th>
<th>PDO</th>
<th>AOI</th>
<th>SST FA</th>
<th>SST KR</th>
<th>SST MW</th>
<th>SST OY</th>
<th>SSTG FA</th>
<th>SSTG KR</th>
<th>SSTG MW</th>
<th>SSTG OY</th>
<th>OY Area</th>
<th>OY SP</th>
<th>KR SP</th>
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<td>0.557†</td>
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<tr>
<td>MW</td>
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</tbody>
</table>

*Hillslope Area Index (HSI), Positional Area (PA)*

- *FA* = FA SST
- *KR* = KR SST
- *MW* = MW SST
- *OY* = OY SST

*Note: * Values in bold are statistically significant at the 0.05 level.

Graphs show the correlation between PA and FA year by year.
3. RESULTS

The relationship between yearly HSI/PA and last year’s climate-ocean indices

|          | Nino 3.4 | NPI | PDO | AOI | SST FA | SST KR | SST MW | SST OY | SSTG FA | SSTG KR | SSTG MW | SSTG OY | OY Area | OY SP | KR SP |
|----------|----------|-----|-----|-----|--------|--------|--------|--------|---------|---------|---------|---------|----------|--------|-------|-------|
| HSI      |          |     |     |     |        |        |        |        |         |         |         |         |          |        |       |       |
| FA       | -0.688   | -0.741 | 0.578 | 0.543 | -0.710 | -0.666 | -0.864 | -0.631 |         |         |         |         |          |        |       |       |
| KR       | -0.692   | -0.732 | -0.807 | 0.569 | 0.615  | 0.727  | 0.684  |         |         |         |         |         |          |        |       |       |
| MW       | 0.543    | -0.653 | 0.754 | 0.626 | 0.688  | 0.550  | 0.604  |         |         |         |         |         |          |        |       |       |
| OY       | 0.556    | -0.582 | -0.684 | 0.705 | 0.666  | 0.640  | 0.574  |         |         |         |         |         |          |        |       |       |
| PA       |          |     |     |     |        |        |        |        |         |         |         |         |          |        |       |       |
| FA       | -0.820   | -0.824 | -0.604 | 0.600 | 0.591  | 0.820  | -0.556 |         |         |         |         |         |          |        |       |       |
| KR       | -0.626   | -0.807 | 1.569 | -0.613 | 0.727  | -0.684 |         |         |         |         |         |         |          |        |       |       |
| MW       | -0.626   | -0.684 | 1.705 | -0.543 | -0.666 | 0.640  |         |         |         |         |         |         |          |        |       |       |
| OY       | 0.574    | -0.824 | -0.684 | 0.705 | 0.666  | 0.640  |         |         |         |         |         |         |          |        |       |       |

**fitted HSI FA**

**fitted HSI FA**

**fitted HSI FA**
3. RESULTS

The relationship between TC and last year’s HSI/PA/climate-ocean

<table>
<thead>
<tr>
<th></th>
<th>Niño 3.4 last year</th>
<th>NPI last year</th>
<th>PDO last year</th>
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</thead>
<tbody>
<tr>
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<td>-0.569</td>
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<td>-0.635</td>
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<tr>
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<td>0.037</td>
<td>0.032</td>
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<tr>
<td>a</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
<td>b</td>
<td>1.404</td>
<td>1010.758</td>
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<td>R2</td>
<td>0.269</td>
<td>0.217</td>
<td>0.333</td>
</tr>
</tbody>
</table>
CONTENT

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4. DISCUSSION

Oceanographic of Fishing Ground

SST \rightarrow Migration
(Ito, et al, 2013)

SST Front \rightarrow Fishing Ground
(Tseng, et al, 2014)

SSTG \rightarrow Aggregation

(Ito, et al, 2013)

(Tseng, et al, 2014)
4. DISCUSSION

The SSTG

Medium and small scales
SSTG can changes the vertical movement of seawater and boundary layer thickness (Chang, 2017)

Large scale
SSTG intensity of the western Pacific Ocean (0°N–10°N, 130°E–150°E) can affects ENSO events (Hoel, Funk, 2013)

SSTG could reflect the complexity of the ocean’s system

Aggregation

Productivity

\[
SSTG_{i,j} = \sqrt{\left(\frac{SST_{i+1,j} - SST_{i-1,j}}{\Delta x}\right)^2 + \left(\frac{SST_{i,j+1} - SST_{i,j-1}}{\Delta y}\right)^2}
\]
4. DISCUSSION

The SSTG

Medium and small scales
SSTG can changes the vertical movement of seawater and boundary layer thickness \((Chang, 2017)\)

Large scale
SSTG intensity of the western Pacific Ocean \((0^\circ N–10^\circ N, 130^\circ E–150^\circ E)\) can affects ENSO events \((Hoel, Funk, 2013)\)

SSTG could reflect the complexity of the ocean’s system

Aggregation

Productivity
4. DISCUSSION

The Regime Shift

Niño 3.4

2016

El Niño + La Niña

HSI

PA

SSTG
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Hope these results could give basic data and information for the stock assessment and management of PS.