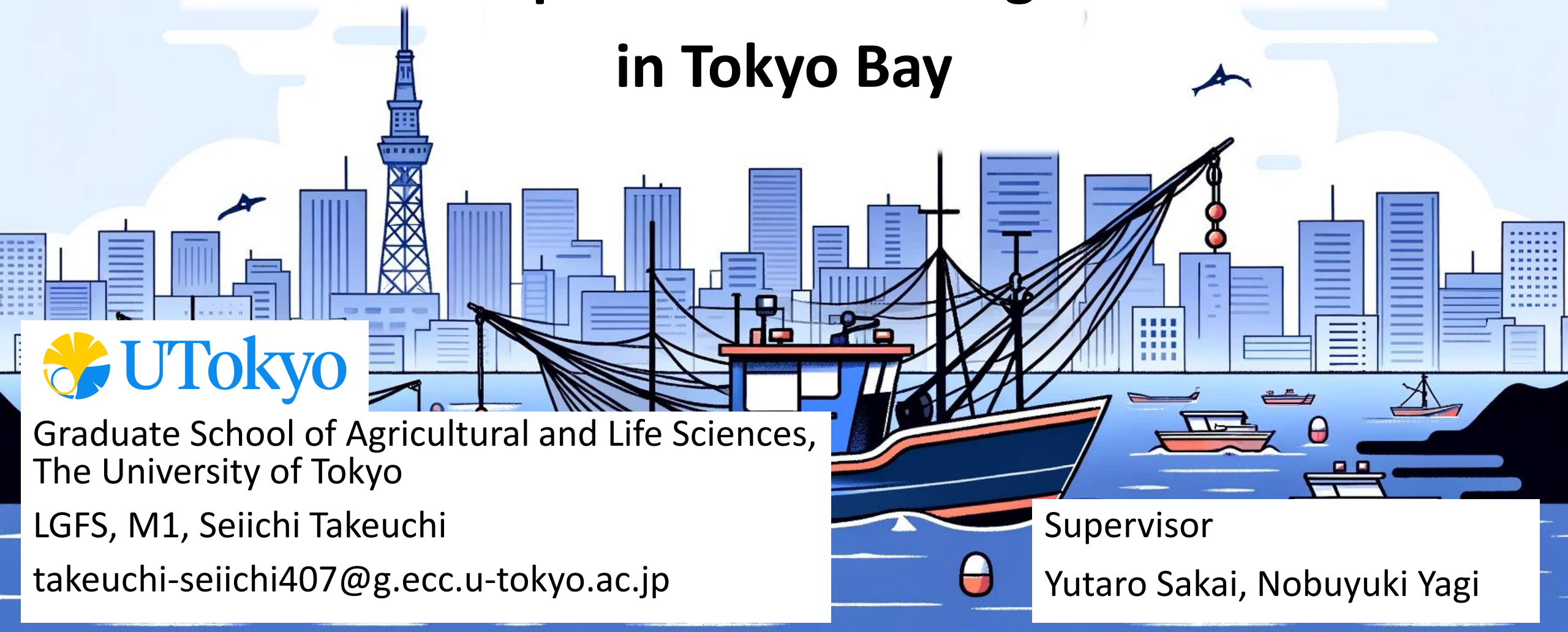
Modeling fish production of purse seine fishing in Tokyo Bay



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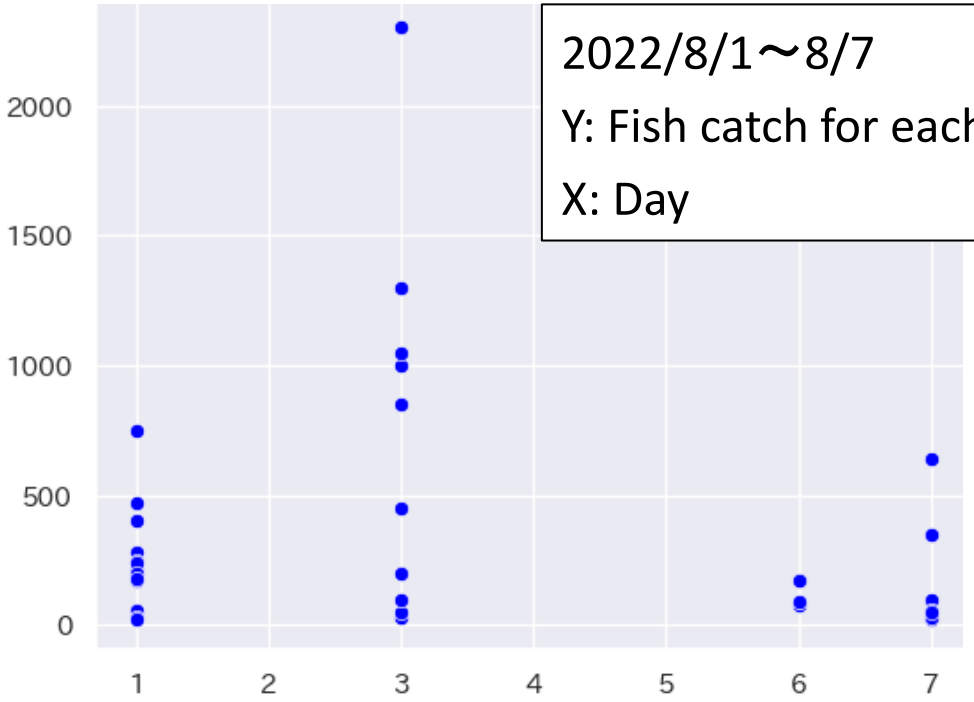
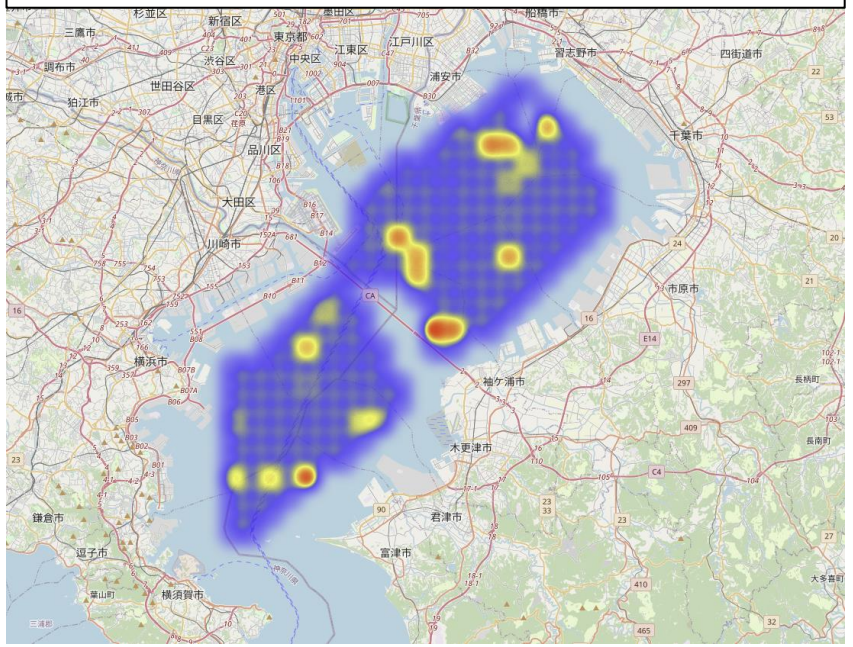
Create catch estimation model

for each net in Purse seine fishing



※ Just a simulation, not actual data



- Fish catch is unstable
- Hard to make a fishing plan

- Estimate how much we can catch fish in each place

1. Predict future fish catch by using previous fish catch

- ARIMA model for predicting fish catch (Tsitsika et al., 2007)
- ANN self-regression for predicting fish catch (Czerwinski et al., 2007)

2. Estimate fish catch from environmental conditions

- Space State model for set net fishing (Kokaki et al., 2018)
- GAM model for squid fishing (Kanemoto, Shibata, 2020)

Nonlinear models which use Previous fish catch Environmental factors as explanatory variables are useful for fish catch estimation

- **Limitation of previous research**
  - Predict/Estimate “per day” or ”per month” catch
  - Cannot consider tiny changes in fishing ground/condition

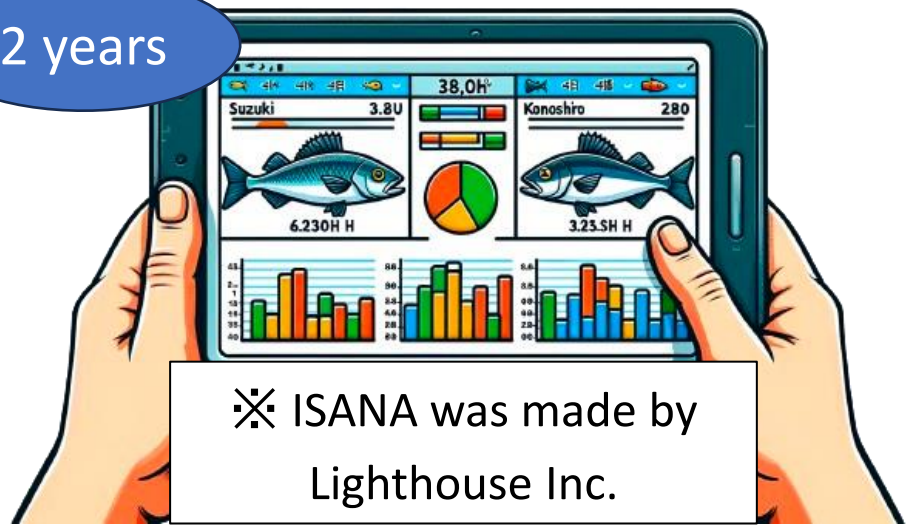
- **Novelties of this research**
  - Estimate per net fish catches in purse seine fishing
  - Clustered fishing grounds
  - Environmental factors of 3 layers (Upper/Middle/Low)
    - Consider tiny changes in fishing grounds/conditions

Consistent with fishers’ experiences

Does it need more detailed data…?

Fish catch (ISANA)

2 years



※ ISANA was made by Lighthouse Inc.

Record fish catch for each net

- Catch date
- Species
- Catch amount
- Location (GPS)
- Fleet (Daidenmaru, Nakasenmaru)

Combine

Environmental factors

Observe 3 layers per hour

- Temperature
- Water temperature
- Wind speed
- Salinity
- pH
- Dissolved Oxygen
- Turbidity
- Flow speed

Log-scaled fish catch per net

Environmental factors	Previous fish catch	Fishing grounds	Dummy variables
Latest 3 times	Average of the latest 3 times	Clustered by K-Means	• Month • Fleet • Year

Sea bass

Gizzard shad

① Variable selection

Generalized Linear Model

Which variables are important?

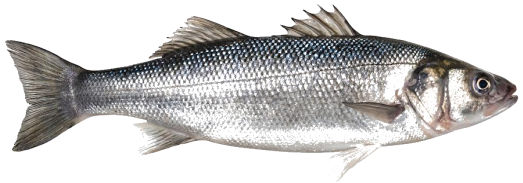
Only Sea bass

② Visualize relationship

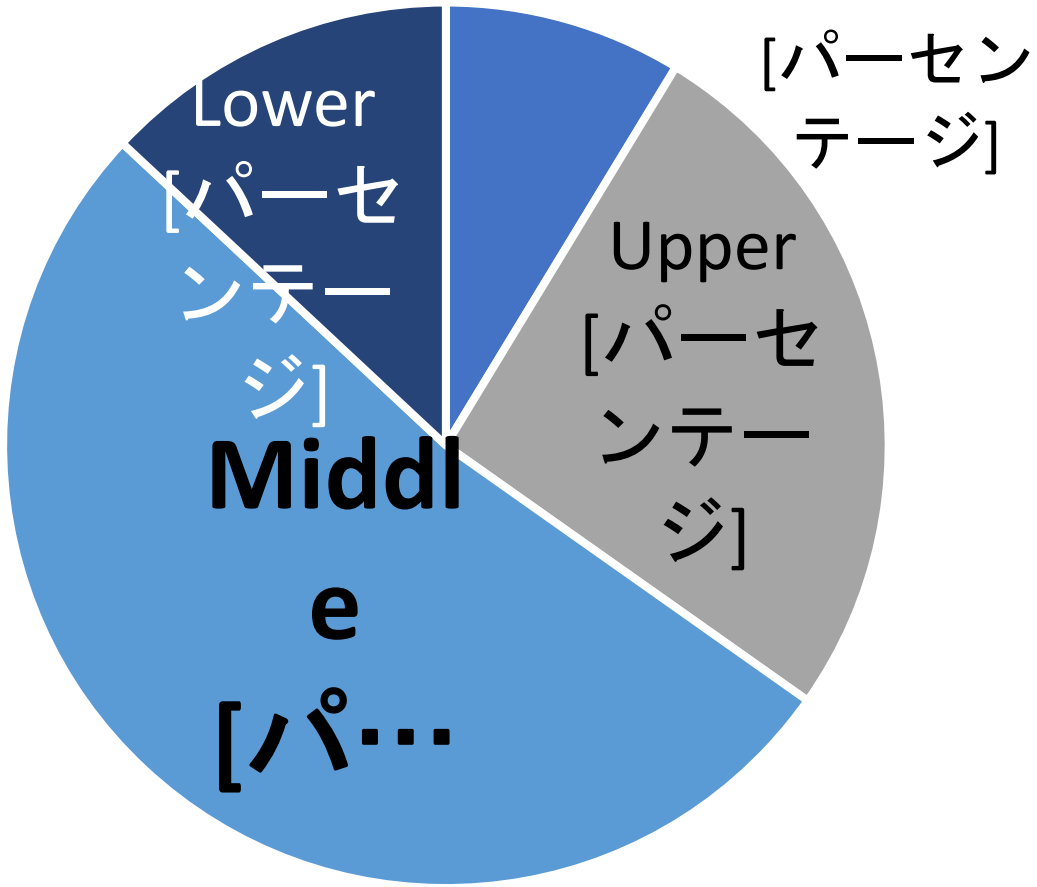
Generalized Additive model

Reveal relationships between fish catch and environmental factors

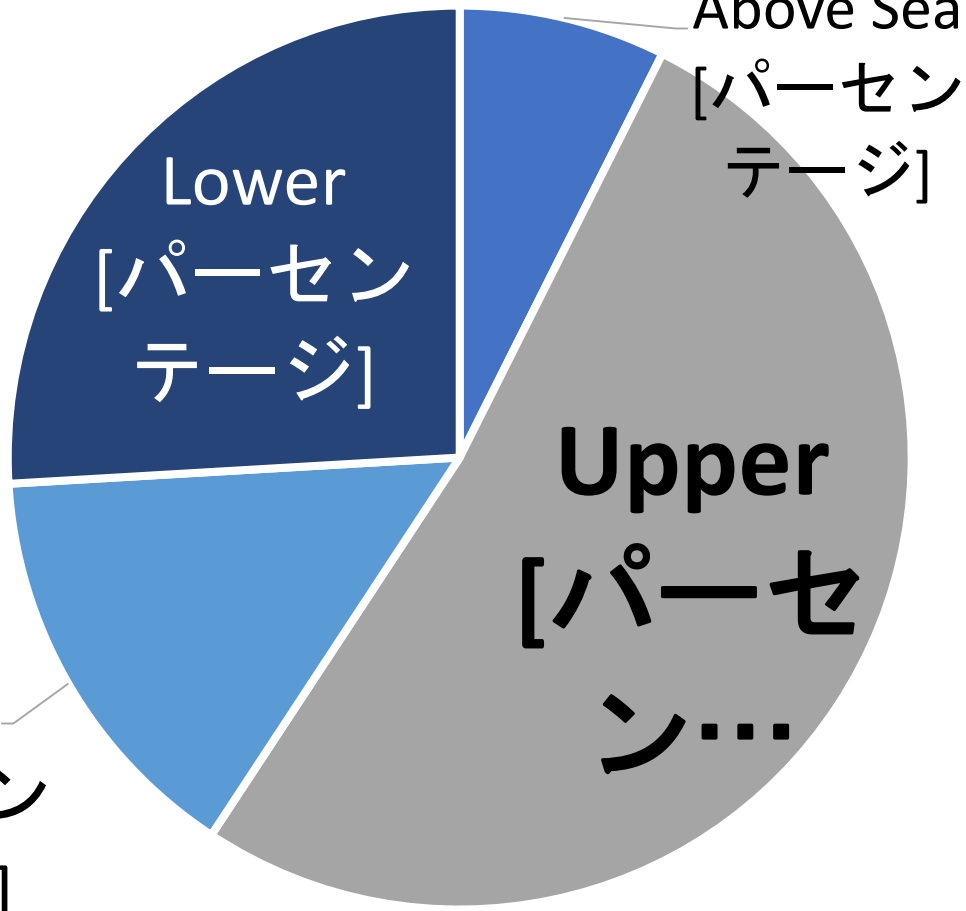
1. Percentages of environmental factors selected in step 1



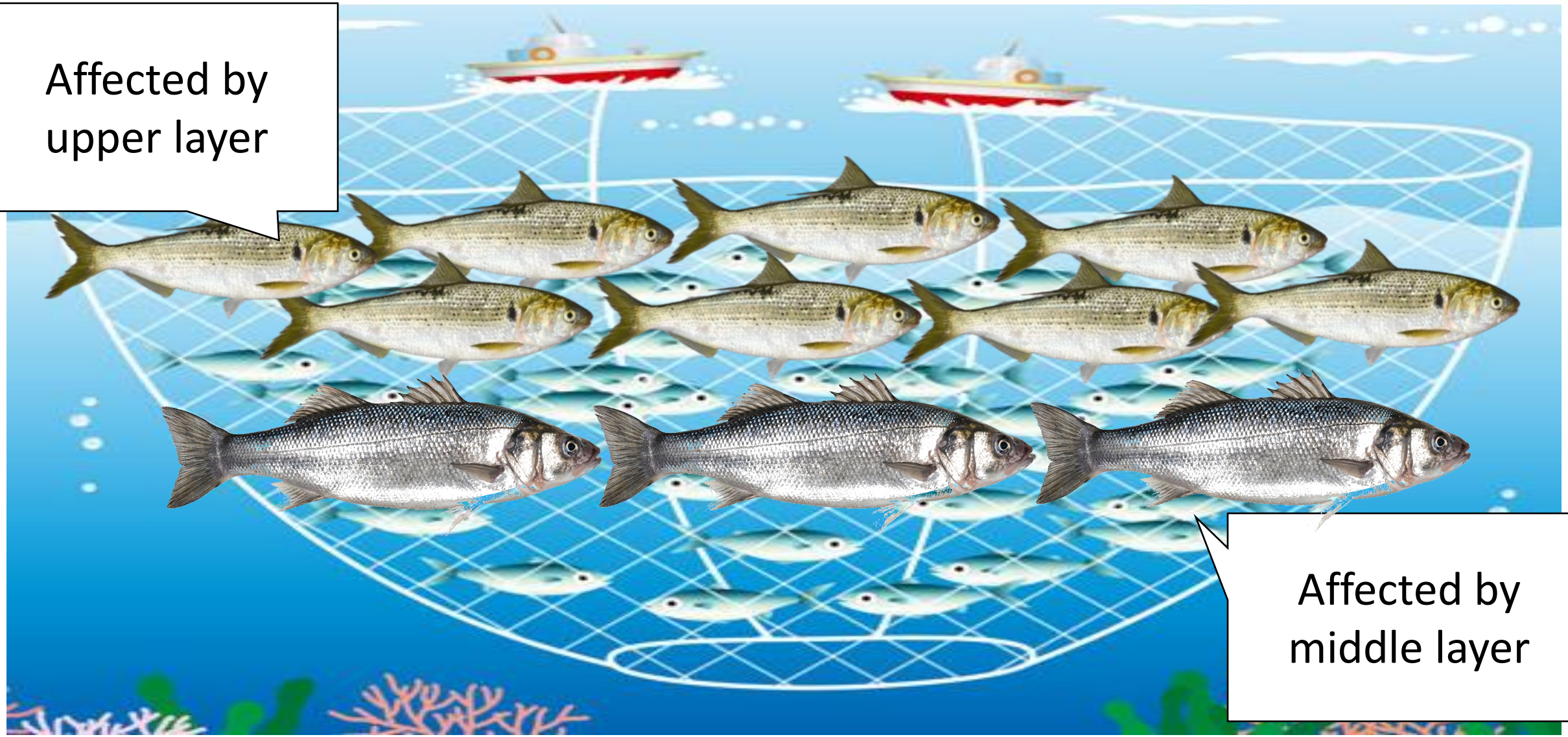
Sea bass



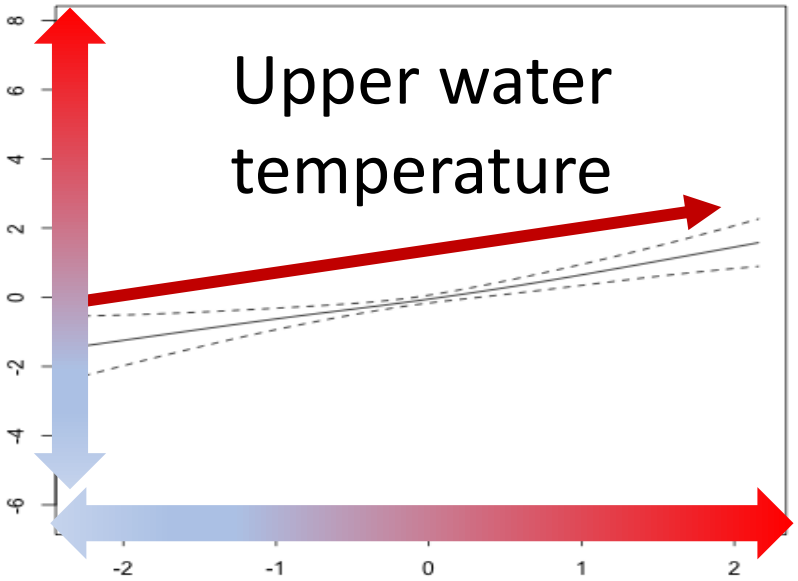
Gizzard shad

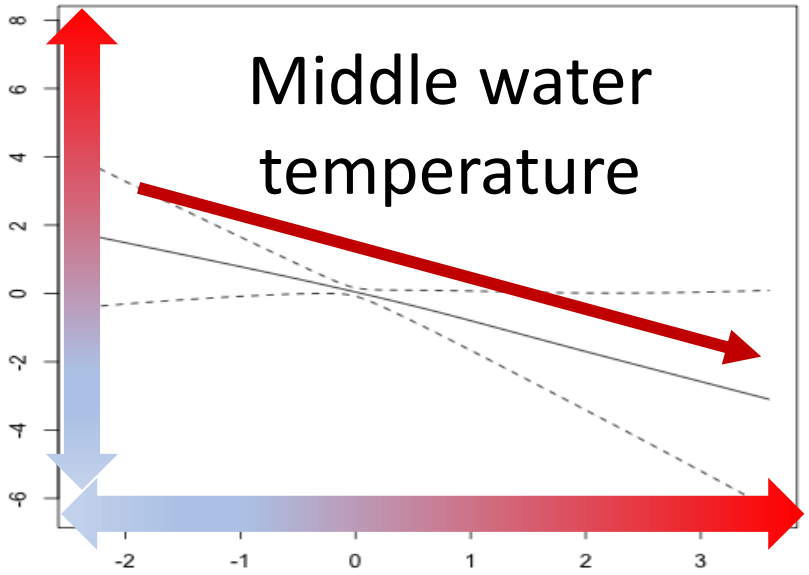


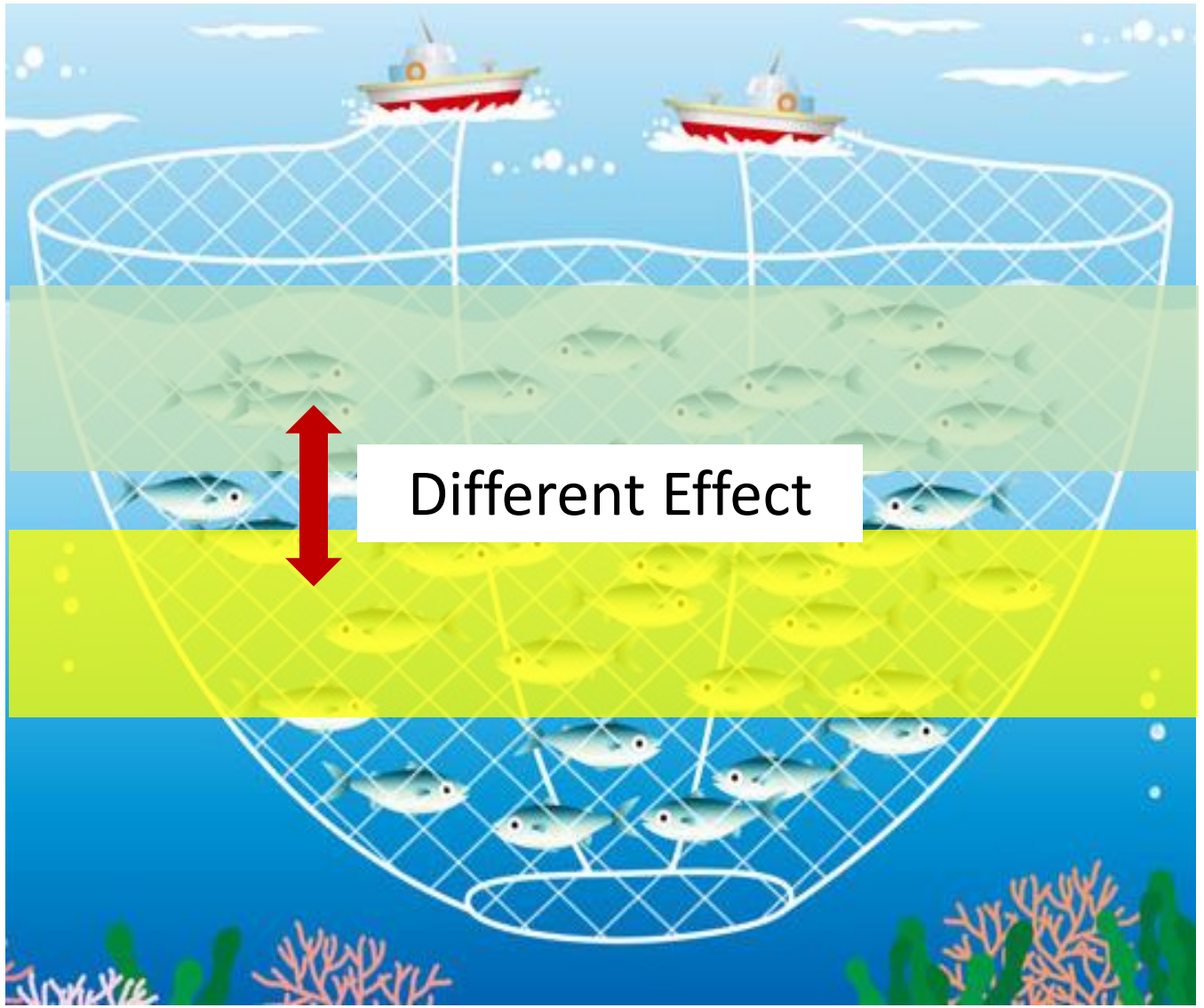
Important environmental factors differ between species



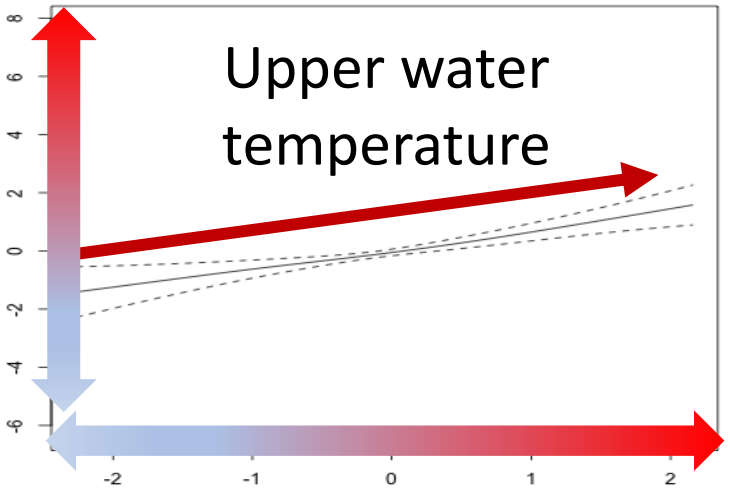
2. Visualize and reveal relationships in step 2

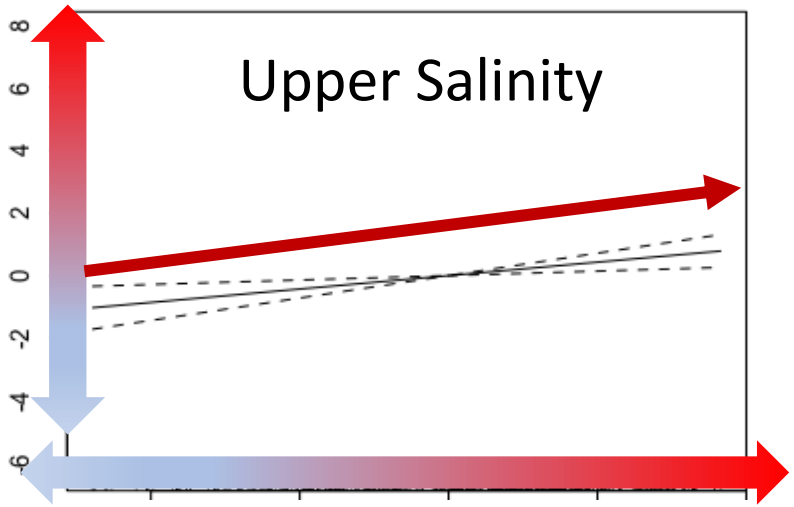


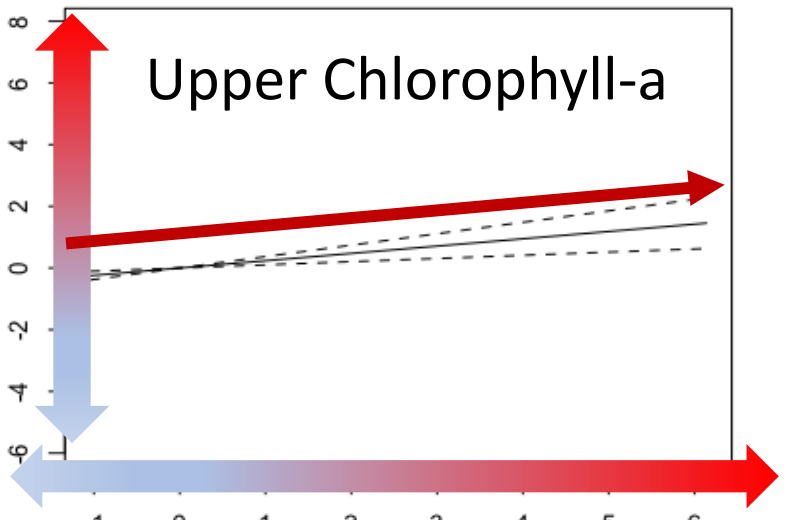


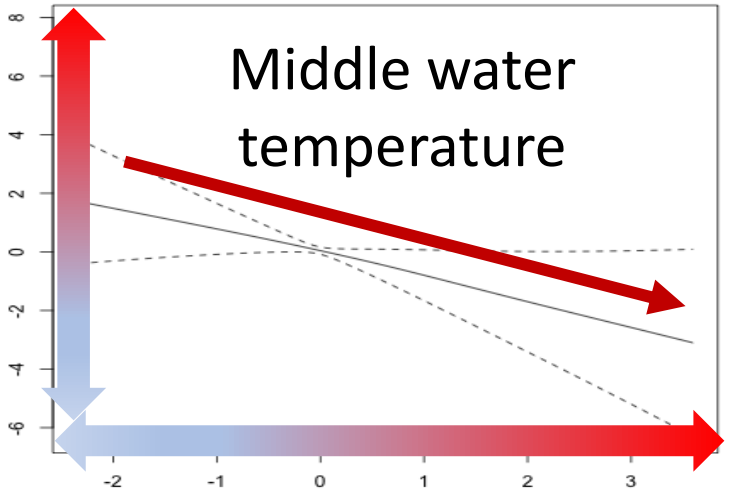


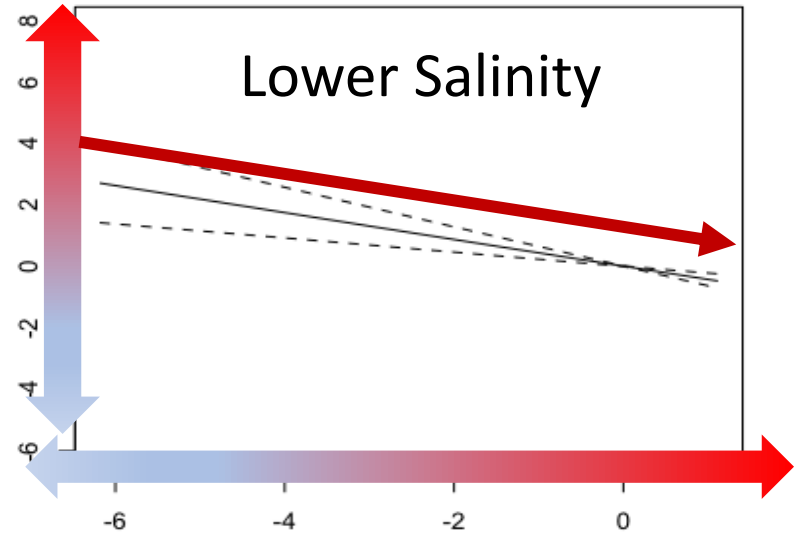
Each environmental factor has different effects on each layer

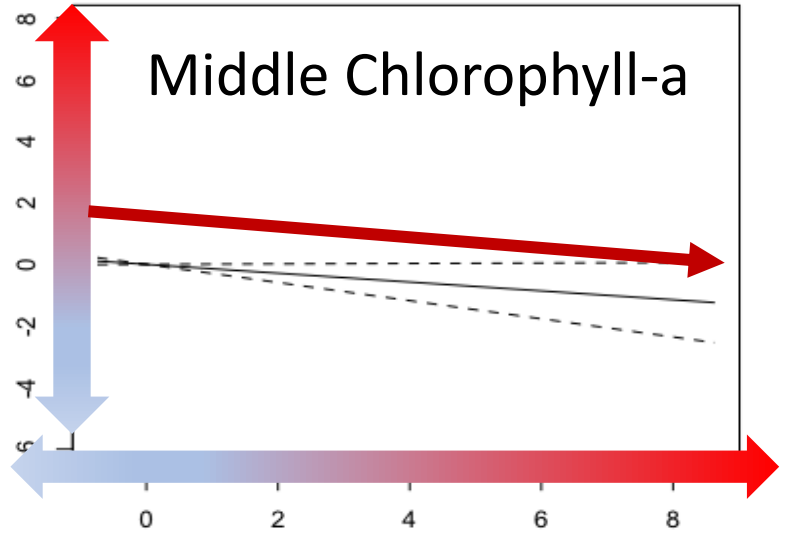












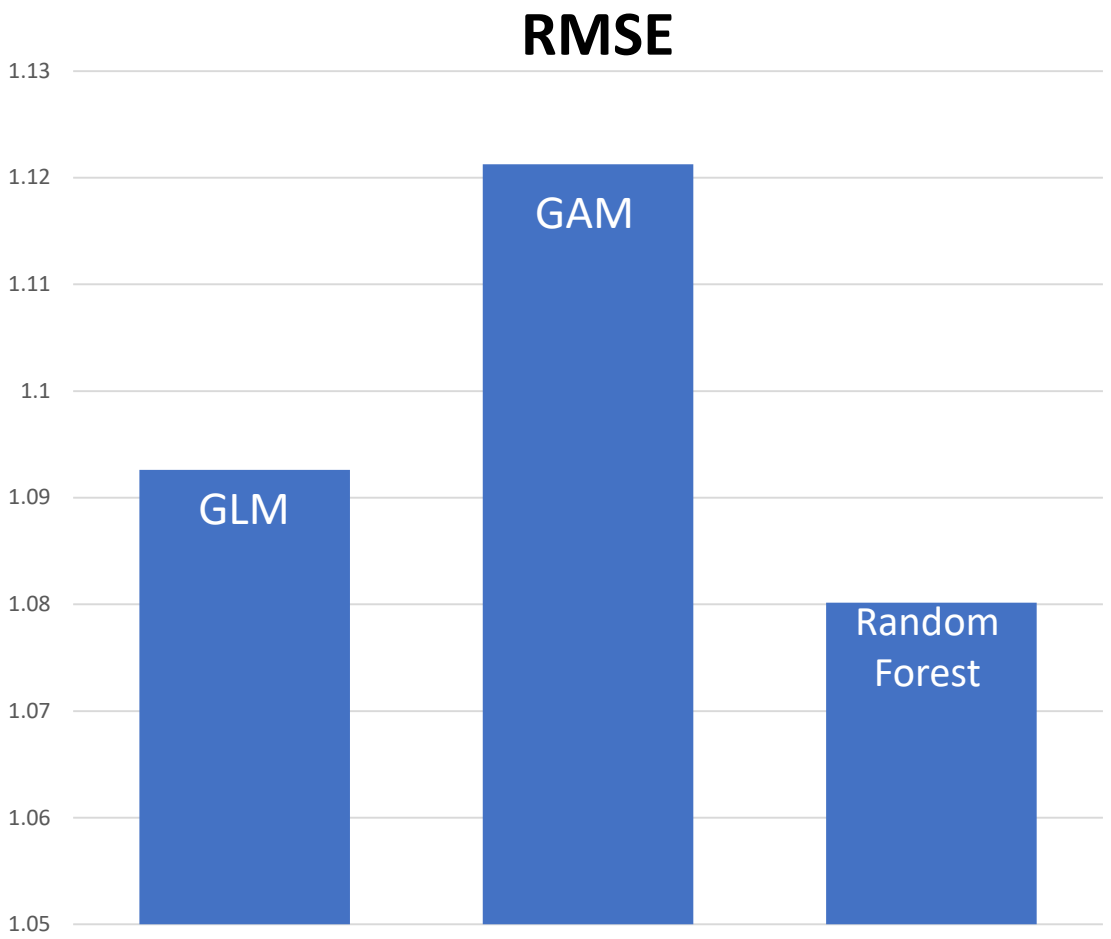
Challenging Point: Accuracy is not so high

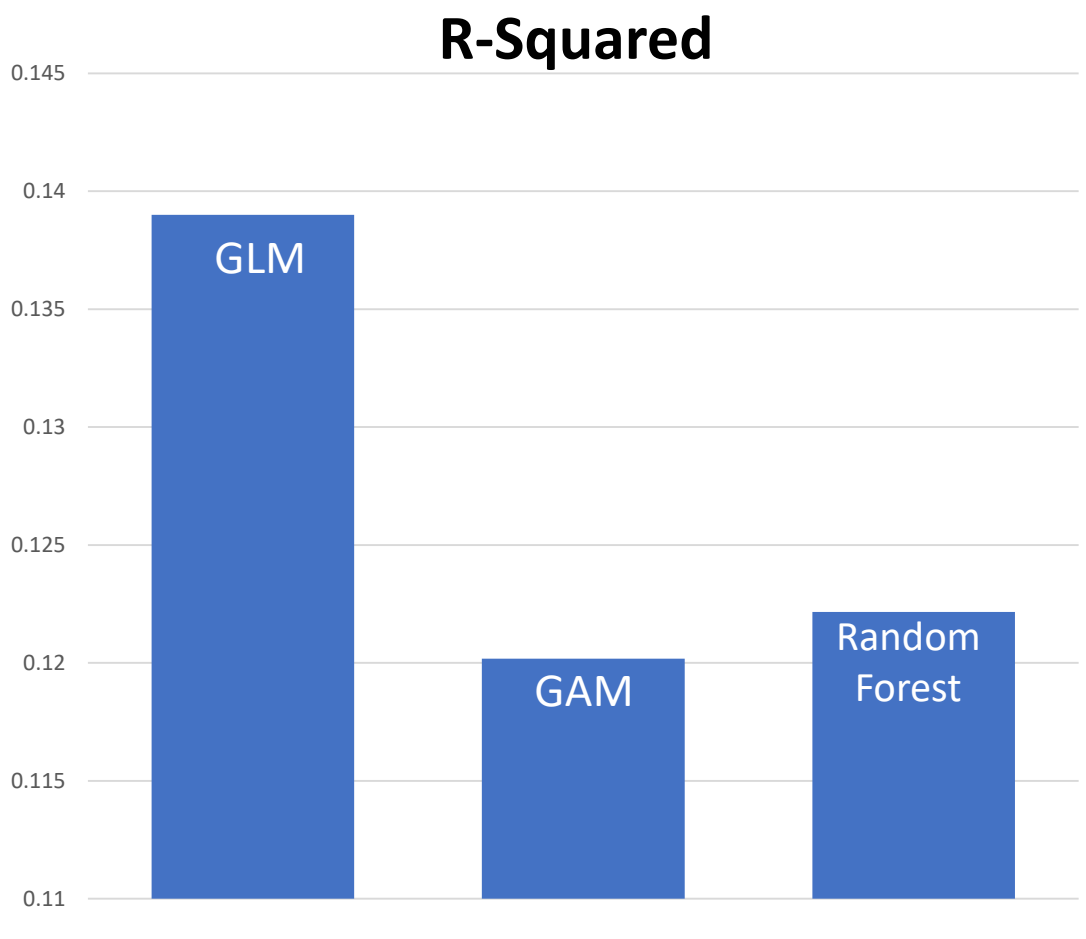
How to improve the accuracy of this model:

Make some simulations for these **2 hypotheses**

1. Apply machine learning or deep learning
   - Try using the Random Forest model
2. Increase the spatial density of the data
   - All data vs ～ High-spatial-density data

1. Apply the machine learning method (Random Forest)





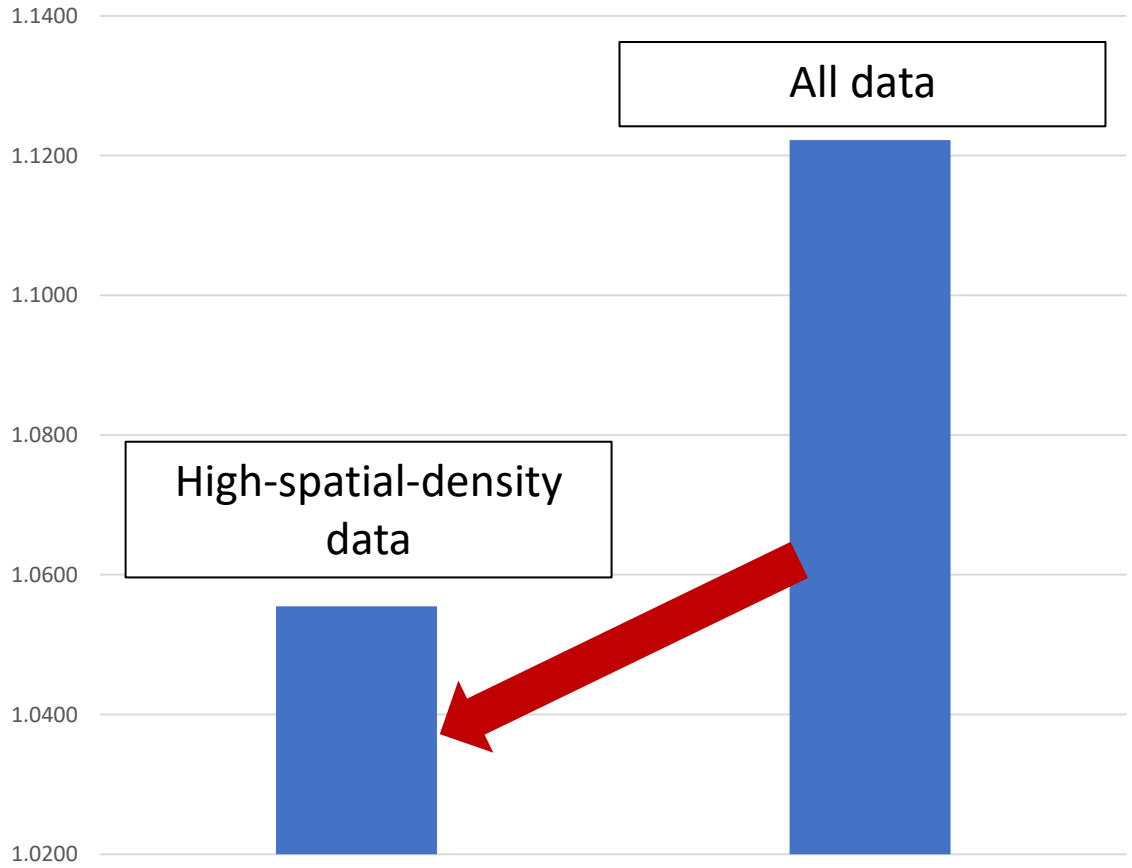
Random forest can decrease RMSE, but not increase R-squared

2. Increase the spatial density of the data

High-spatial-density data

Only the data within the red circle (~ 5km)

RMSE of the random forest model



If the spatial density of the data increases, the model will improve

Conclusion: Findings of this research

1. Find some considerations when building fish catch estimation models
   - Important environmental factors differ between species
   - Each environmental factor has a different effect on each layer
2. The accuracy of the model for estimating fish catch per net is still low
   - There are several ways it can be improved
     - Apply machine learning methods
     - Increase the spatial density of the data

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