Deep learning and surplus production models for multivariate autoregressive modelling and simulation of the jack mackerel fishery associated with environmental conditions

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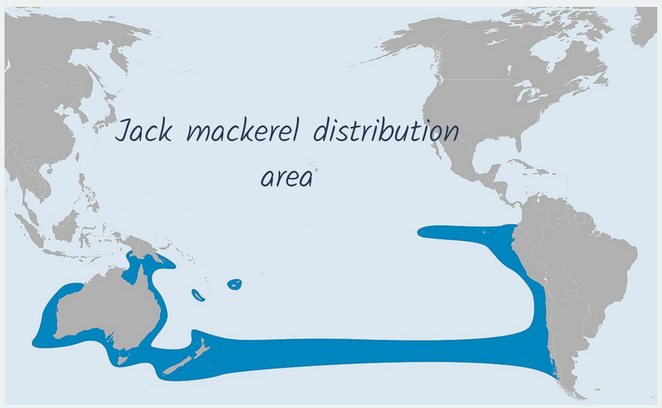
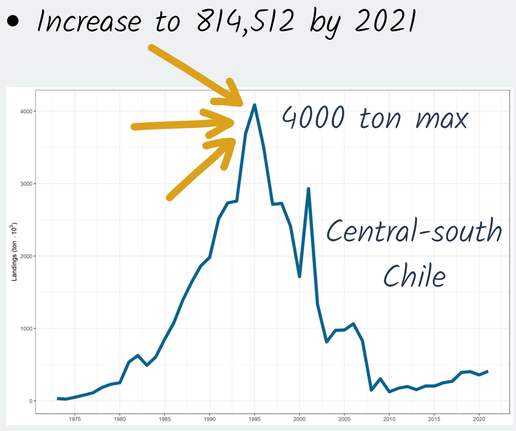
Background



- SPRFMO records catches from 16 countries since 1970

- Maximum of 4,955,186 t in 1995
- Drastical decrease to 353,120 t by 2013
- Increase to 814,512 by 2021



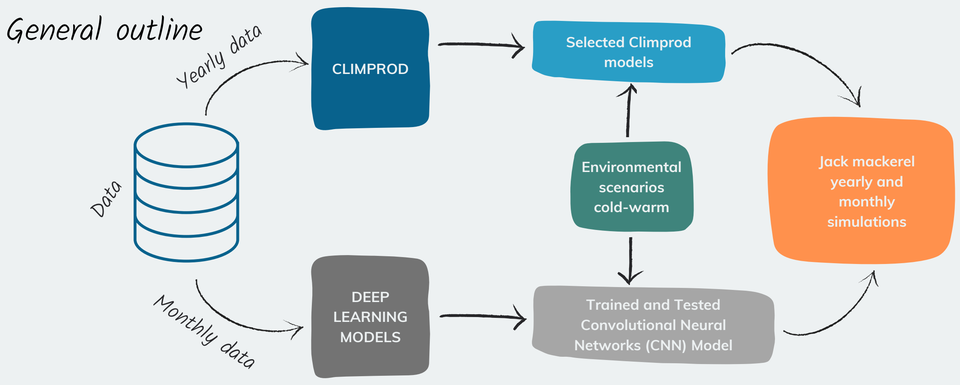
Our approach

Data:

Variables from 1973-2021

- Chilean central-south catches (C);
- Catch per standard unit of effort (CPUE) as abundance index of industrial purse-seine fleet off central-southern Chile;
- Standard fishing effort (E=C/CPUE); and
- NOAA satellite SST between 32°-42°S-71°-80°W.

General outline



Results

CLIMPROD yearly predictions

Model considerations

- 5 significant age classes
- recruitment at 2 years
- environment affecting abundance between 0-2 years

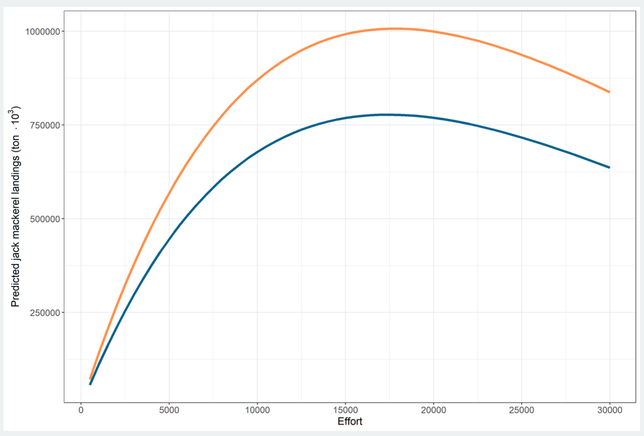
$$CPUE = (a\,SST^{b} + d\,E)^{\frac{1}{c-1}}$$

Model's Performance

$R^2 = 0.90$ $(p < 0.001)$

$R^2_{jackknife} = 0.86$

$T_{jackknife}$ = 'good'



Warmer period (SST 2018-2021)

1007036 t

Colder Period (SST 1999-2014)

777500 t

Estimated MSY Projections

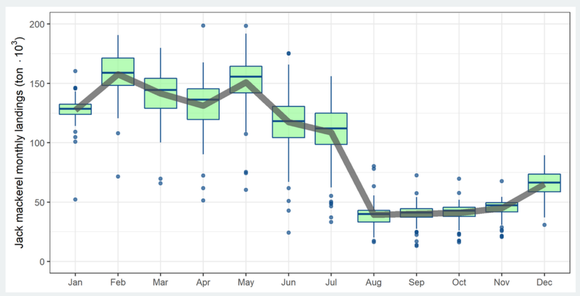
Results

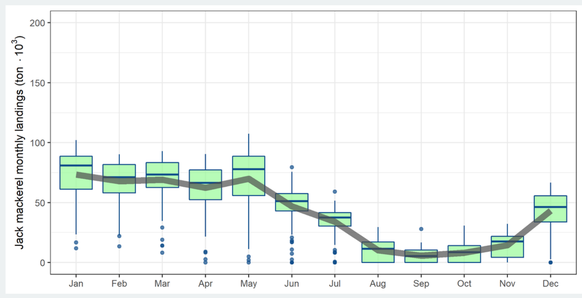
Monthly CNN predictions

Model's Performance

Mean $R^2 = 0.842$
Sd $R^2 = 0.073$

Monthly projections





Yearly sum of montlhy projections

Warmer period (SST 2018-2021)

Mean: 1165582 t
Sd: 147741 t

Colder Period (SST 1999-2014)

Mean: 504848 t
Sd: 179556 t

Conclusions

Lessons learned

- Both models consider the environment .
- Conventional models consider Yearly MSY projections
- Deep learning approach models monthly fishery time-series dynamic extending to monthly MSY projections.
- Helpful to managers and gives insight on the possible effects of the environment on the fishery.

Future work

- Complex models can be integrated: age-structured, growth models, fishing effort scenarios, new DL structures.
- More fisheries and fisheries data, with spatial component.
- Forecast models for ecosystemic changes, to quantify abundance-fishery dynamic, such as climate change and long-term environmental changes.

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