Stock assessment of small yellow croaker considering the impact of yellow goosefish predation in the East China Sea

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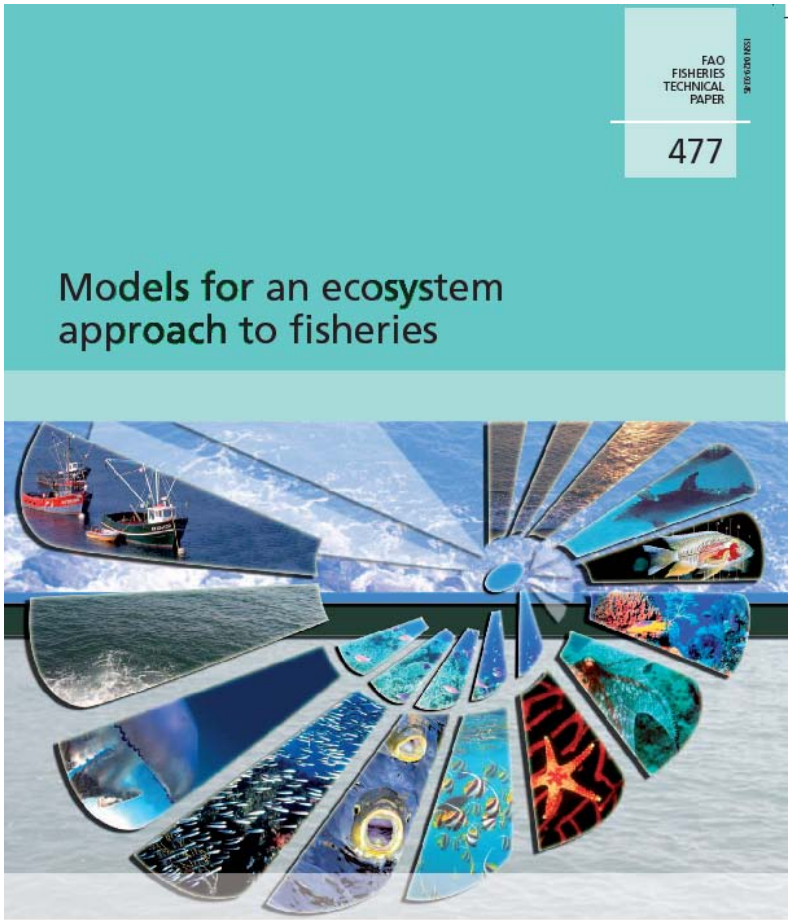

FAO Fisheries Technical Paper 477

by Éva E. Plagányi (2007)

2. Review of current modelling approaches

- 2.1 Whole ecosystem and dynamic system models
  - 2.1.1 ECOPATH with ECOSIM (EwE)
  - 2.1.2 Biogeochemical models
  - 2.1.3 ERSEM and SSEM
  - 2.1.4 IGBEM, BM2 and ATLANTIS
  - 2.1.5 SEPODYM/SEAPODYM
- 2.2 Minimum realistic models
  - 2.2.1 The original MRM
  - 2.2.2 ESAM (Extended Single-species Assessment Models)
  - 2.2.3 MSVPA approach
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  - 2.5.1 Predator-prey models
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  - 2.5.3 EPOC model (Ecosystem Productivity Ocean Climate Model)
  - 2.5.4 Mori and Butterworth multi-species model
  - 2.5.5 SMOM (Spatial Multi-species Operating Model)

Prey of Yellow goosefish

Yellow goosefish

Other food

Anchovy

Chefoo thryssa

Common hairfin anchovy

Horse mackerel

Chub mackerel

Yellow croaker

White croaker

croaker

Vertical striped cardinalfish

Hair tail

Agassiz's snailfish

Tanaka's snailfish

Butterfish

Belenger's jewfish

Black throat sea perch

Bluefin sea robin

Lizardfish

Spearnose grenadier

Pinkgray goby

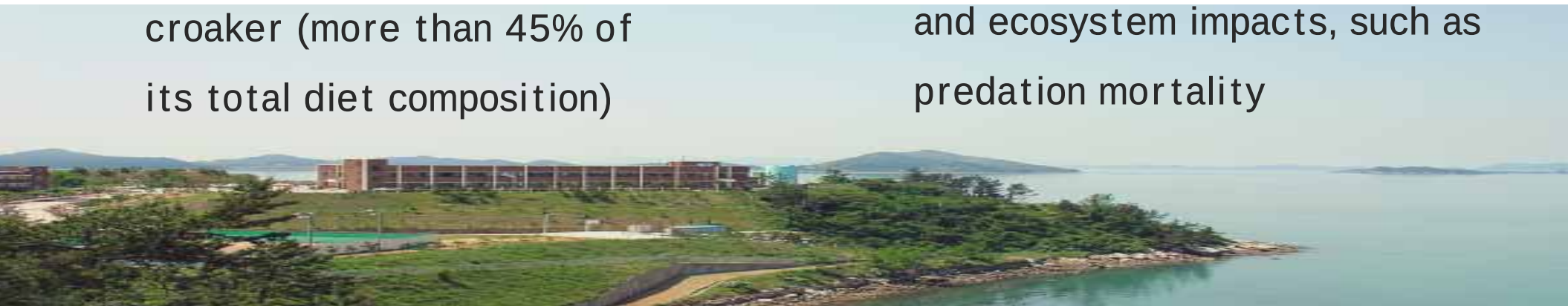
- From yellow goosefish stomach, 69 fish species were found.

Yellow goosefish

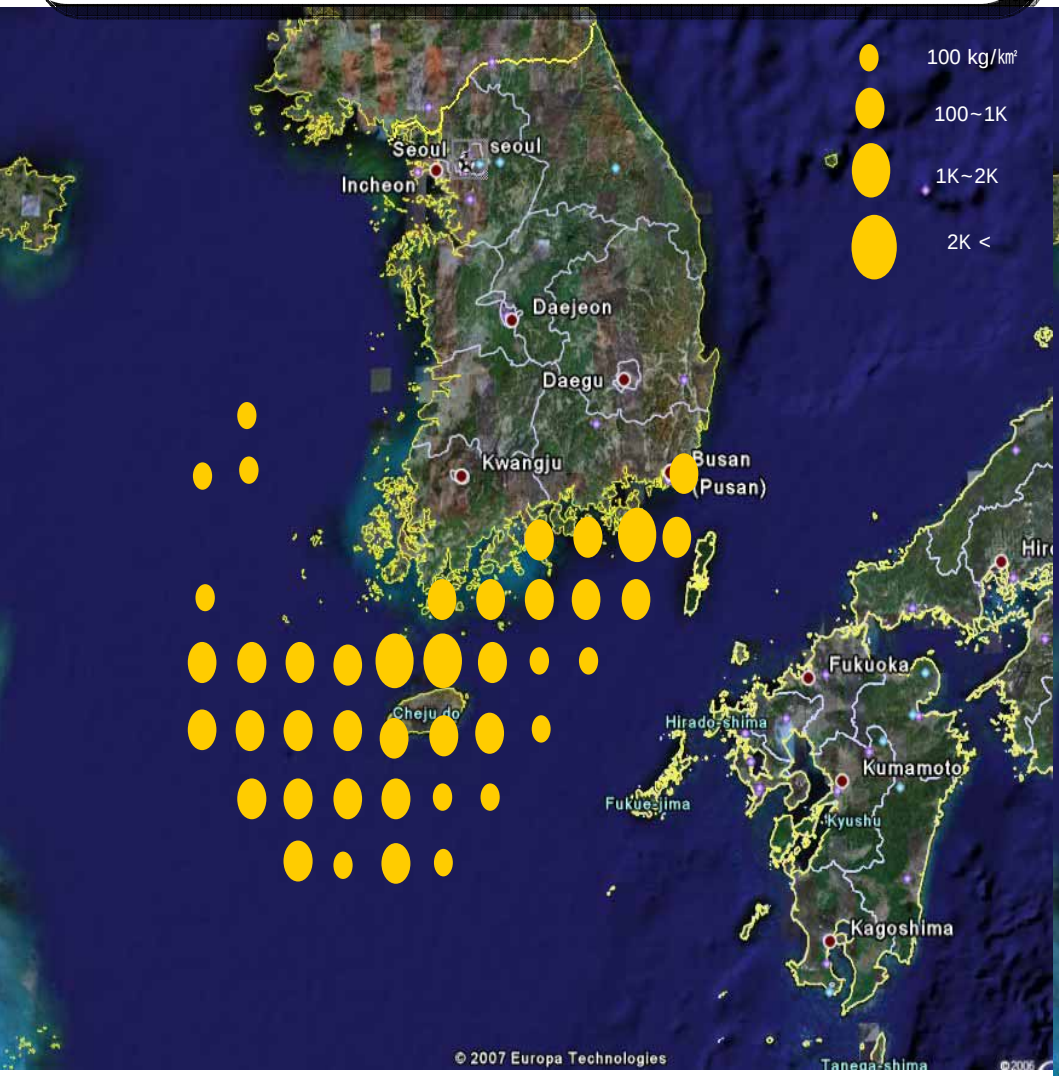
- ✓ *Lophius litulon*
- ✓ Valuable groundfish
- ✓ Max. size: 150 cm
- ✓ High TL species in food web as a predator with a BIG MOUTH
- ✓ Mainly feeds on small yellow croaker (more than 45% of its total diet composition)

Small Yellow croaker

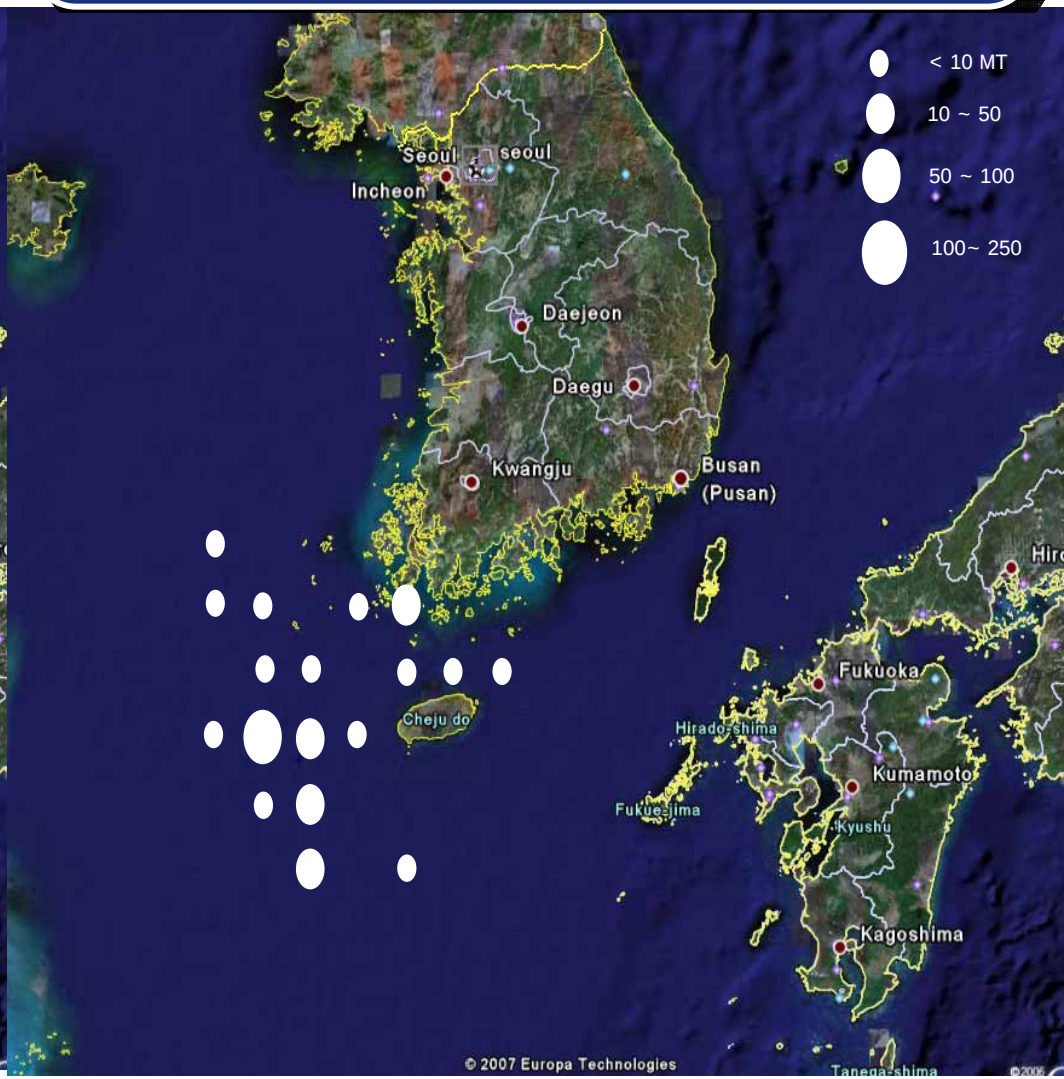
- ✓ *Larimichthys polyactis*
- ✓ one of the most valuable fish species and ecologically important species in Korean marine ecosystem
- ✓ This fish stock has been decreasing due to overfishing and ecosystem impacts, such as predation mortality



Distributions of Yellow goosefish (Winter)

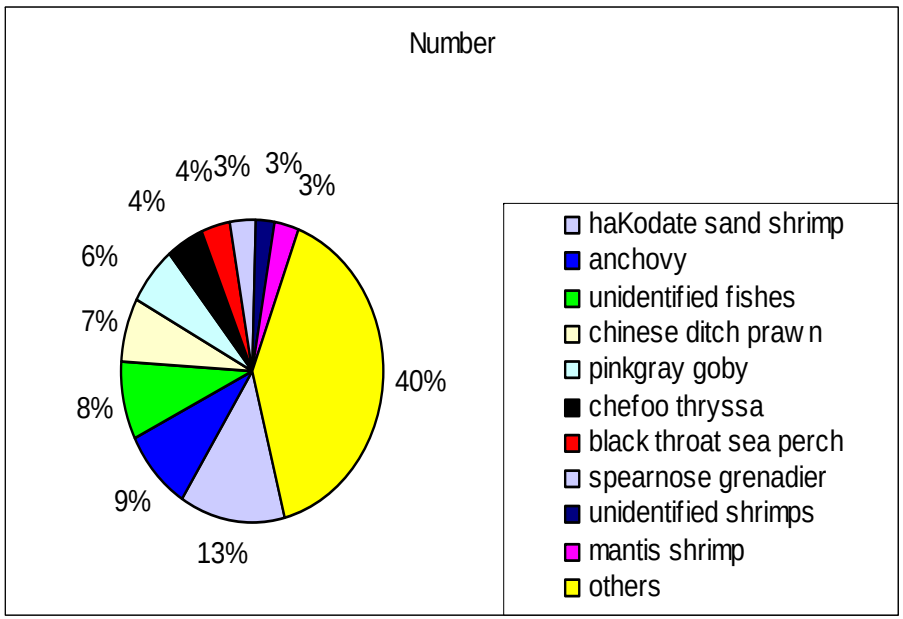


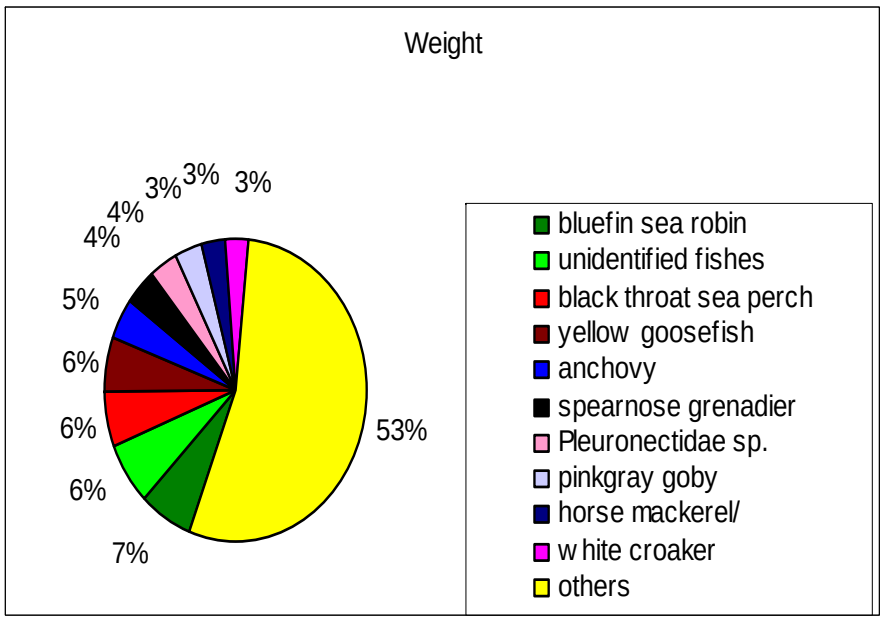
Small yellow croaker (Winter)



Stomach contents of Yellow goosefish

South Coast (2004-2006)

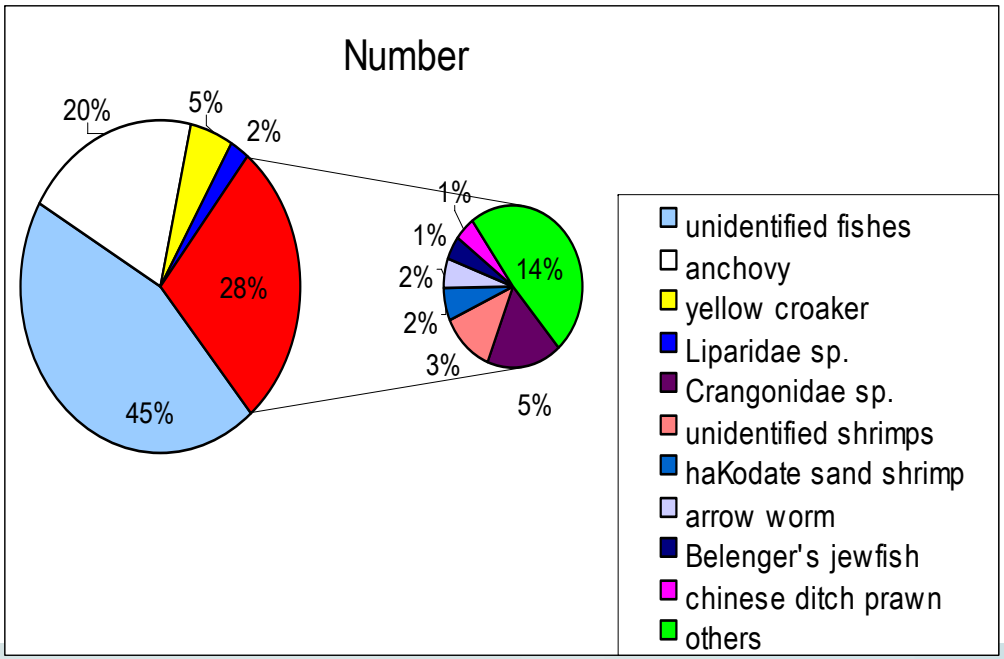


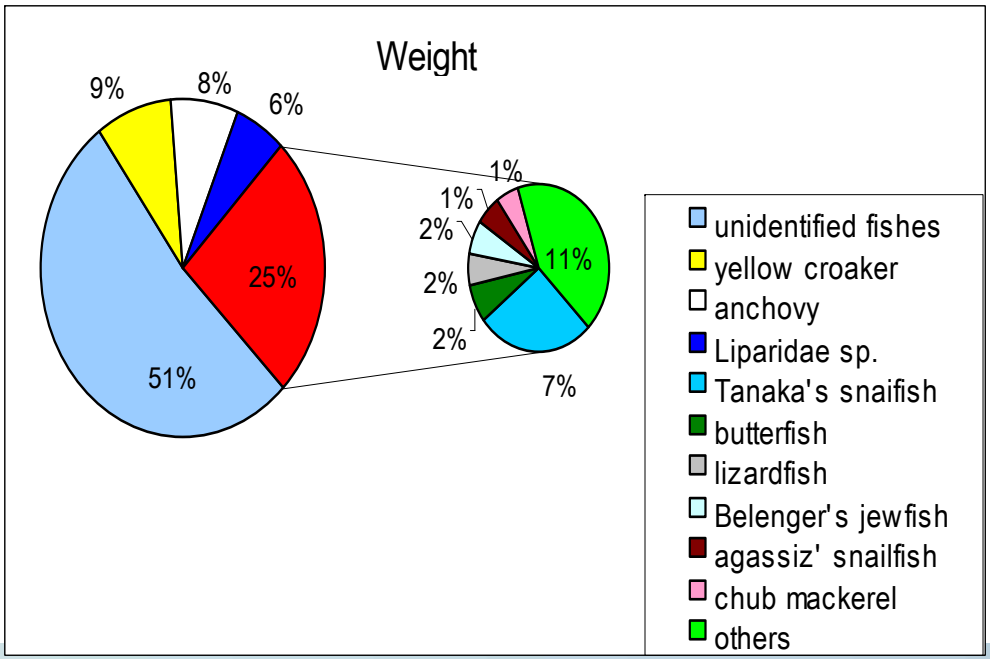


- Dominant species of stomach contents are **hakodate sand shrimp**, **anchovy** and small size **fishes** in the coastal area.

Stomach contents of Yellow goosefish

EEZ (2004-2005)

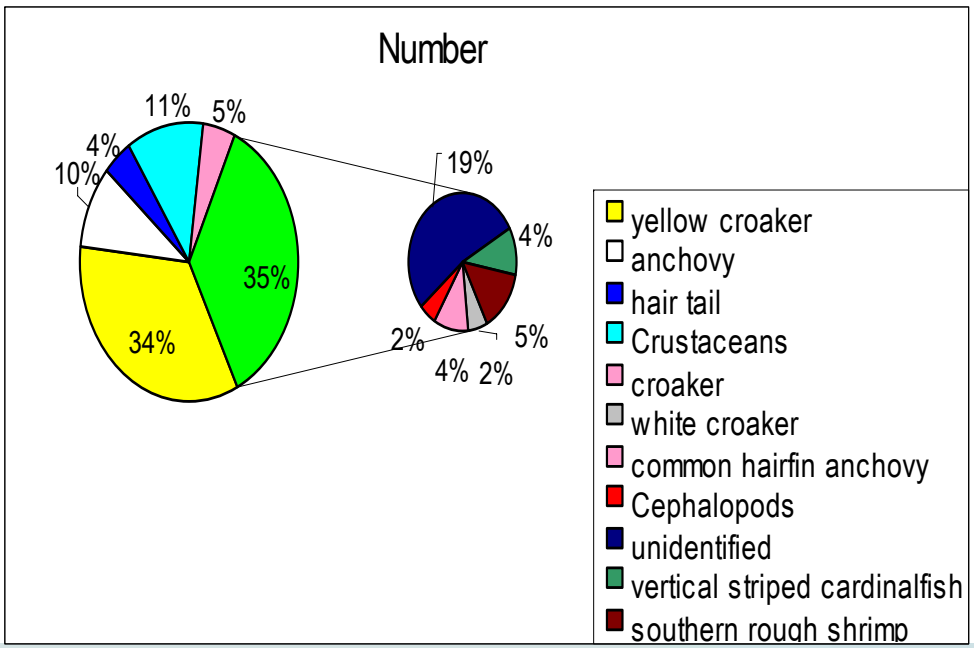


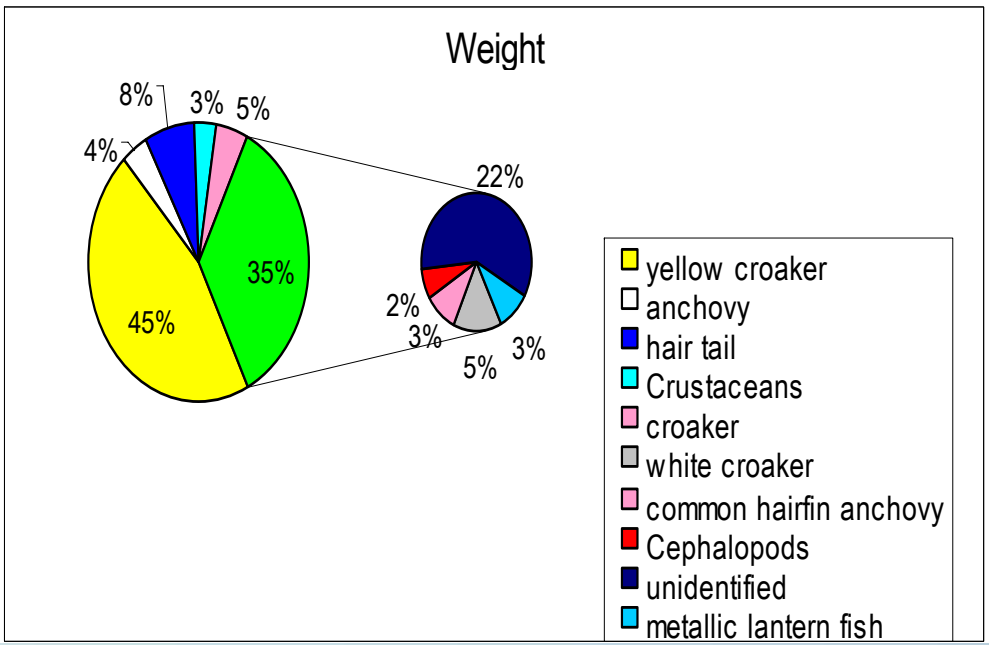


- Dominant species of stomach contents are **anchovy** and **small yellow croaker** in the EEZ of Korea.

Stomach contents of Yellow goosefish

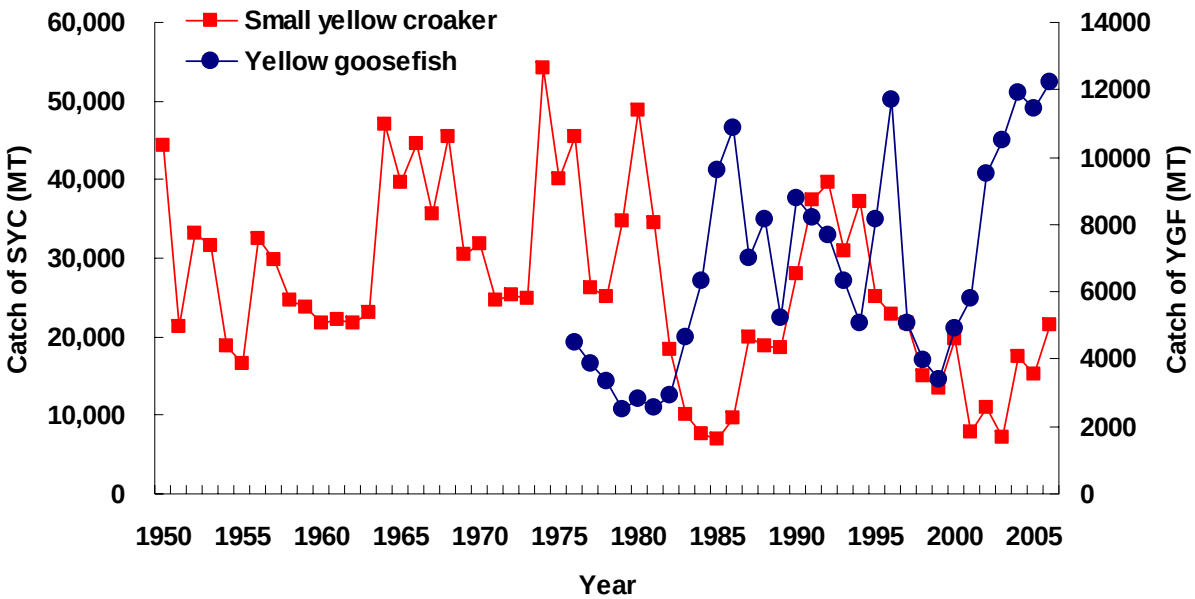
ECS (1994-1997)

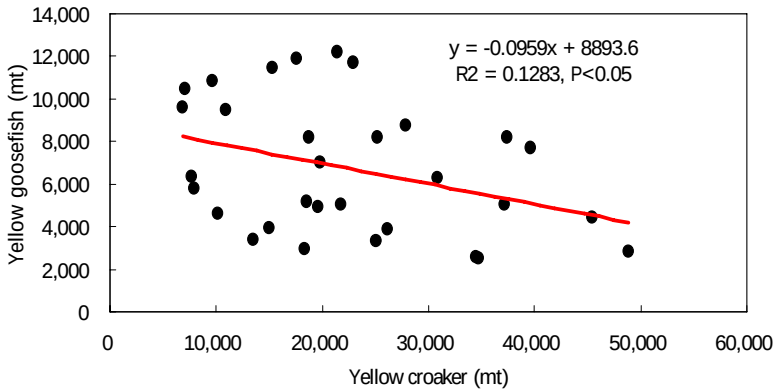




- Dominant species of stomach contents are **small yellow croaker**, **anchovy** and **hairtail** in the East China Sea.
- Measured age of prey

Fishery data

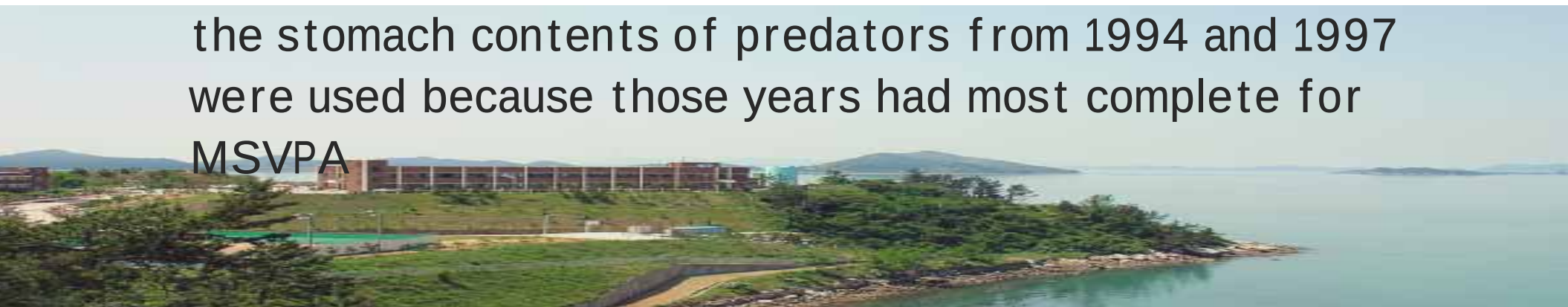




- Annual variations of catch of small yellow croaker showed a negative correlationship with that of yellow goosefish in Korean waters.

Multispecies Virtual Population Analysis

- Common input data included catch-at-age data (only landings), maturity-at-age, and weight-at-age
- Input data of the MSVPA included stomach content data, prey (small yellow croaker, anchovy, hairtail) weight-at-age in the predator stomach contents, predator (yellow goosefish) annual ration, and natural mortality.
- Stomach content data and estimates of weight-at-age in the stomach contents of predators from 1994 and 1997 were used because those years had most complete for MSVPA



Predation equations

$$M = M1 + M2$$

$$M2_{p,a} = \sum_i \sum_a \frac{S_{i,j,p,a} R_{i,j} \bar{N}_{i,j}}{BS_{i,j}}$$

$$BS_{i,j} = S_{i,j,of} + \sum_p \sum_a S_{i,j,p,a} W_{p,a} \bar{N}_{p,a}$$

$$S_{p,a,i,j} = \frac{U_{p,a,i,j} / \left(\bar{N}_{p,a} W_{p,a,i,j}\right)}{\sum_p \sum_a U_{p,a,i,j} / \left(\bar{N}_{p,a} W_{p,a,i,j}\right)}$$

S - suitability coefficient of prey *p* for predator *i*

BS - suitable prey biomass

R - annual ration of the predator *i*

W - weight at age of prey *p*

M2 - predation mortality

M – natural mortality, M1 – residual mortality,

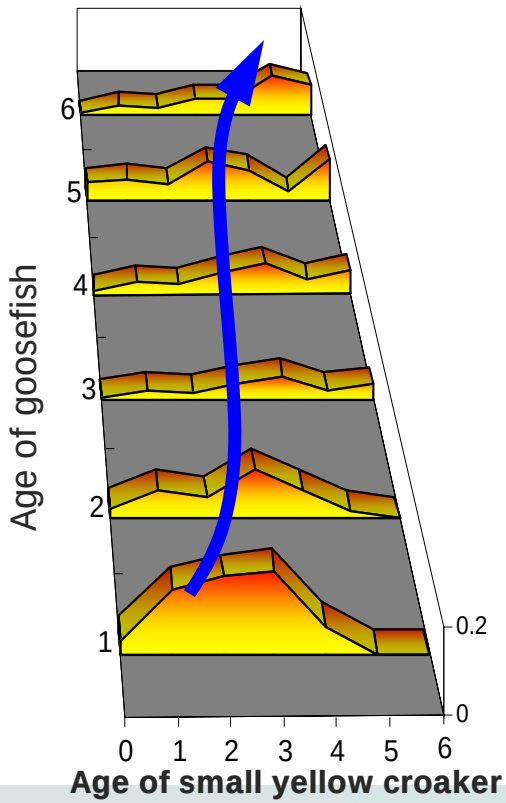
U - stomach content

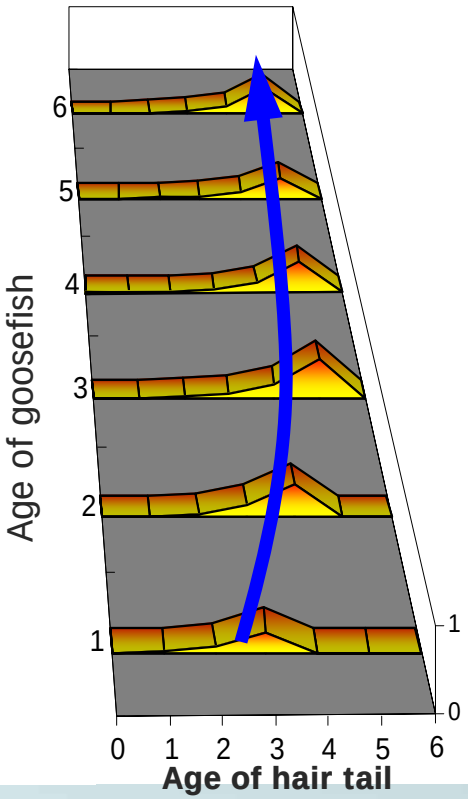
- avg. predator population, - avg. prey population

- To estimate the stock size from catch at age data and stomach contents of predators, predation mortalities must be known

- To calculate predation mortality, the stock size and the suitabilities must be known

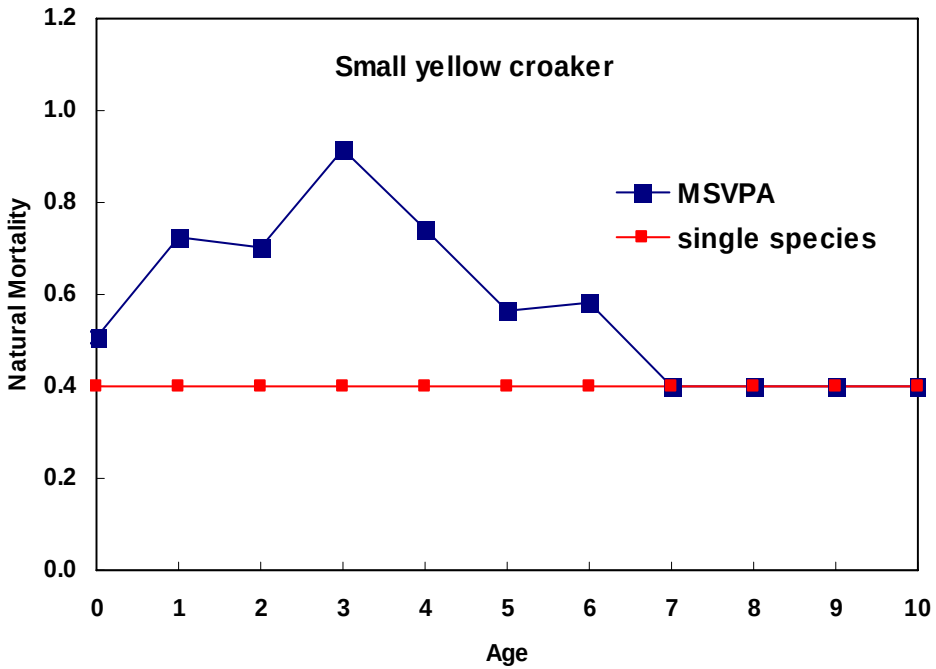
Average suitability

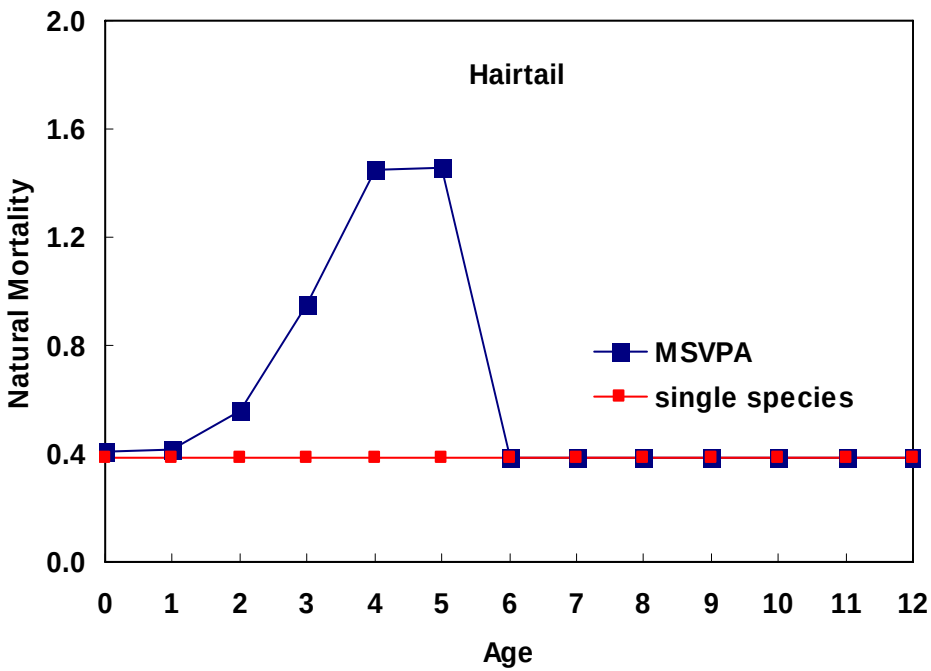




Larger yellow goosefish feed on older prey species.

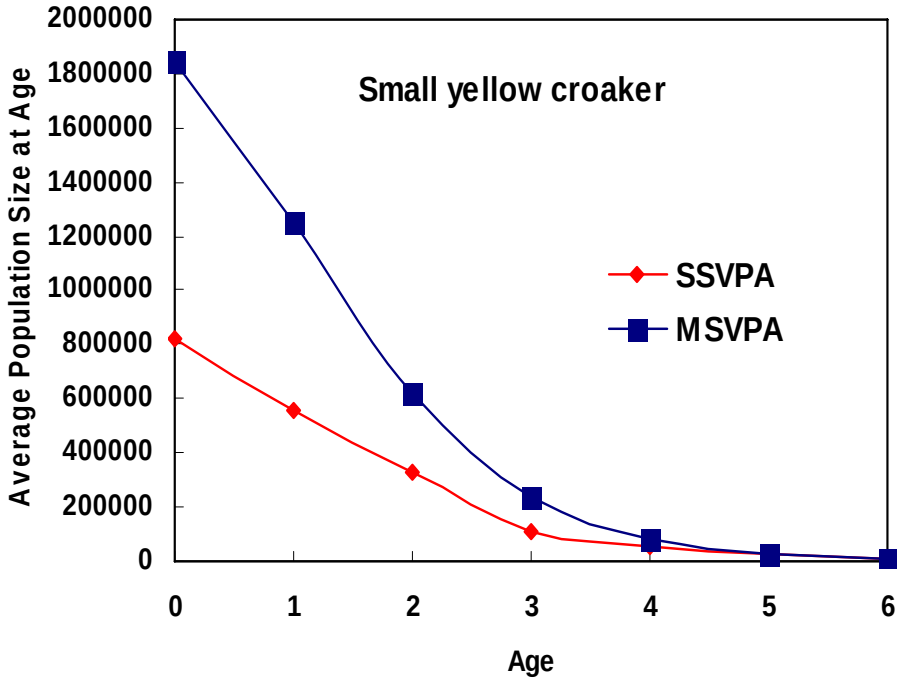
Comparison of natural mortality

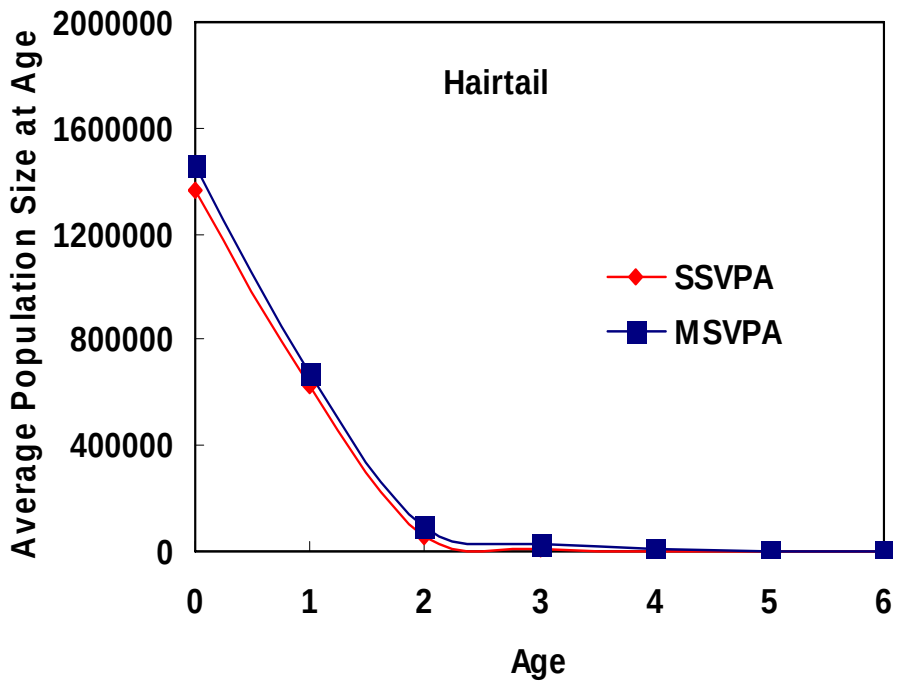




Predatory natural mortality of small yellow croaker was highest at age 3 and that of hairtail was at age 4-5.

Comparison of average abundance

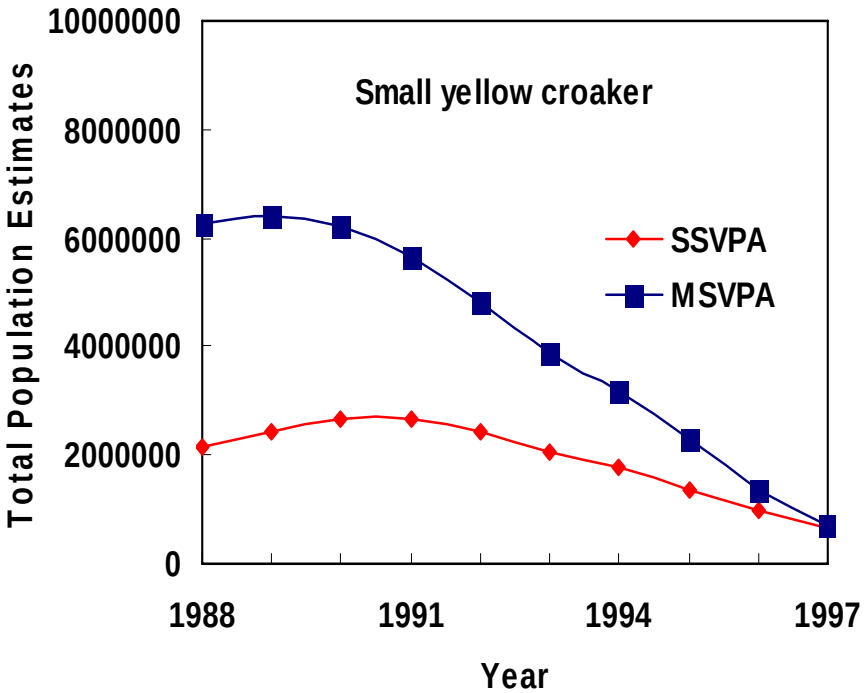


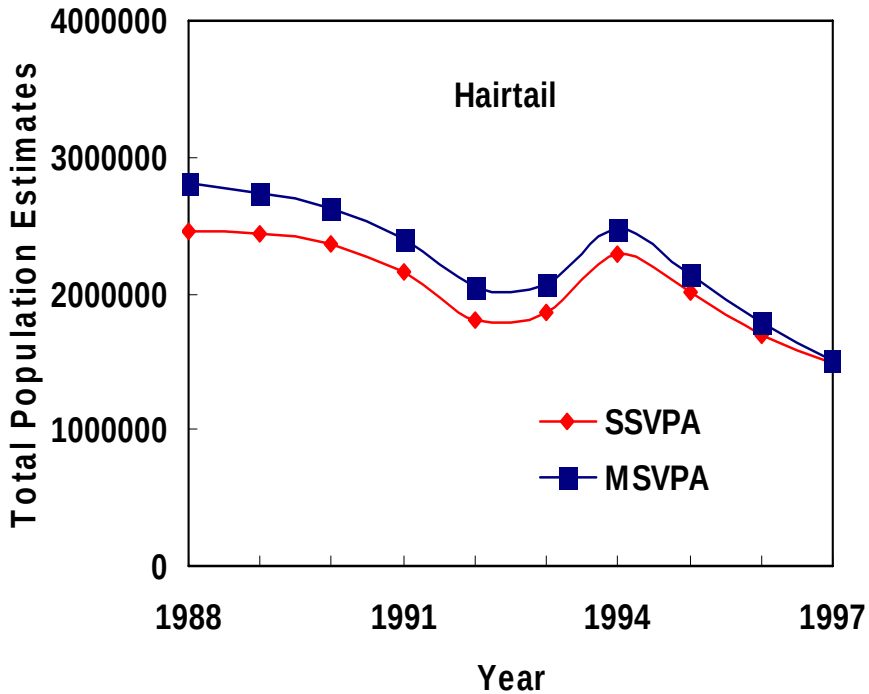


Average abundance estimates of prey species by MSVPA were higher than those by SSVPA.

The difference of small yellow croaker was high until age 2.

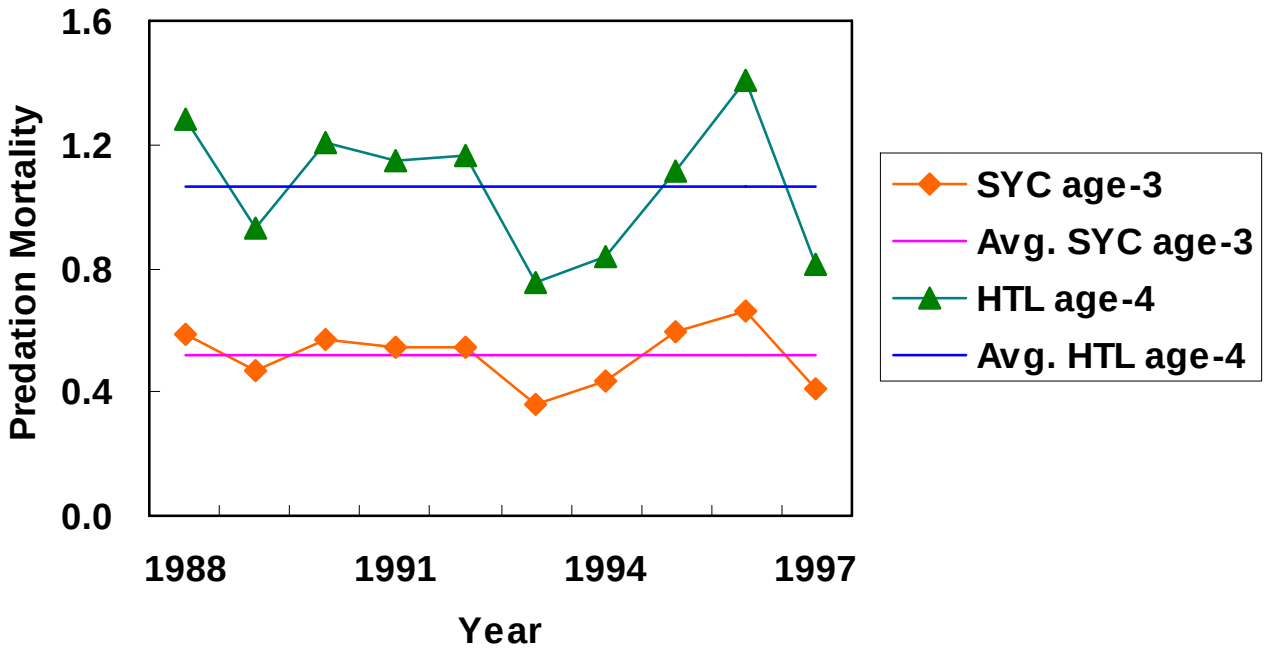
Temporal trend of prey stock size





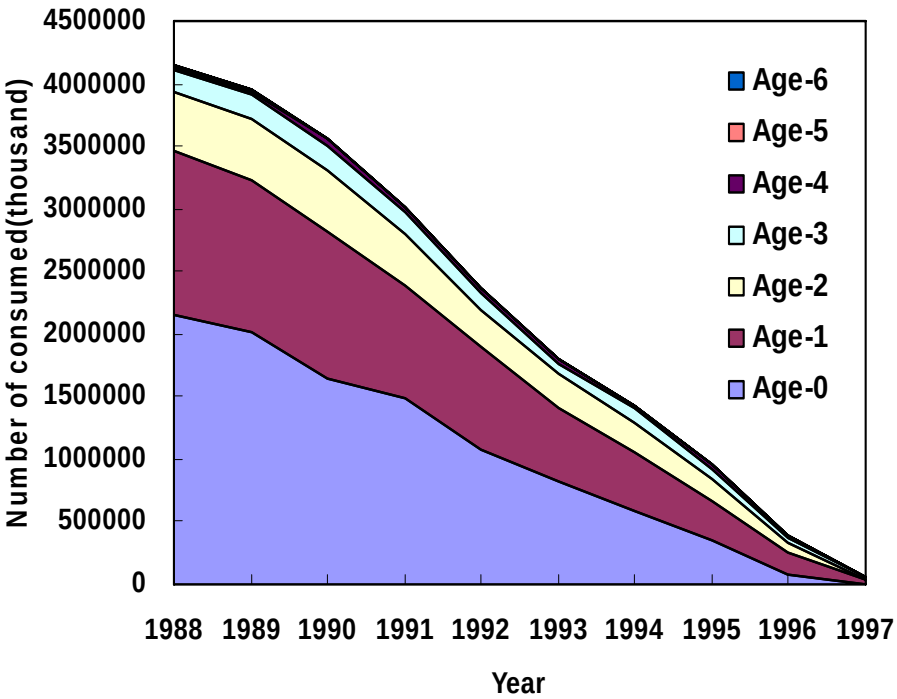
Total population estimates of prey species by MSVPA were higher than by SSVPA.

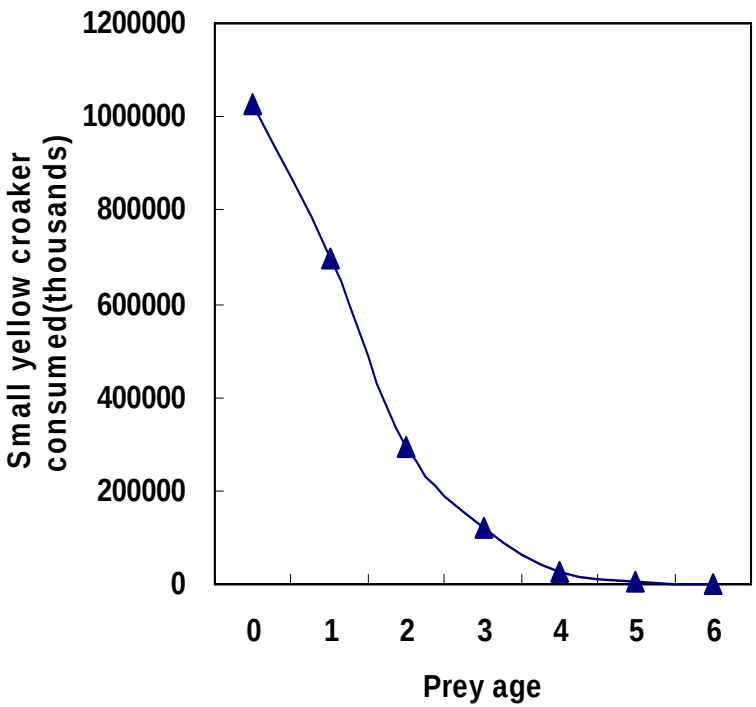
Temporal trends of predation mortality



Predation mortalities of prey species at age 3 showed a similar variation pattern from 1988-1997.

Small yellow croaker consumed by Yellow goosefish

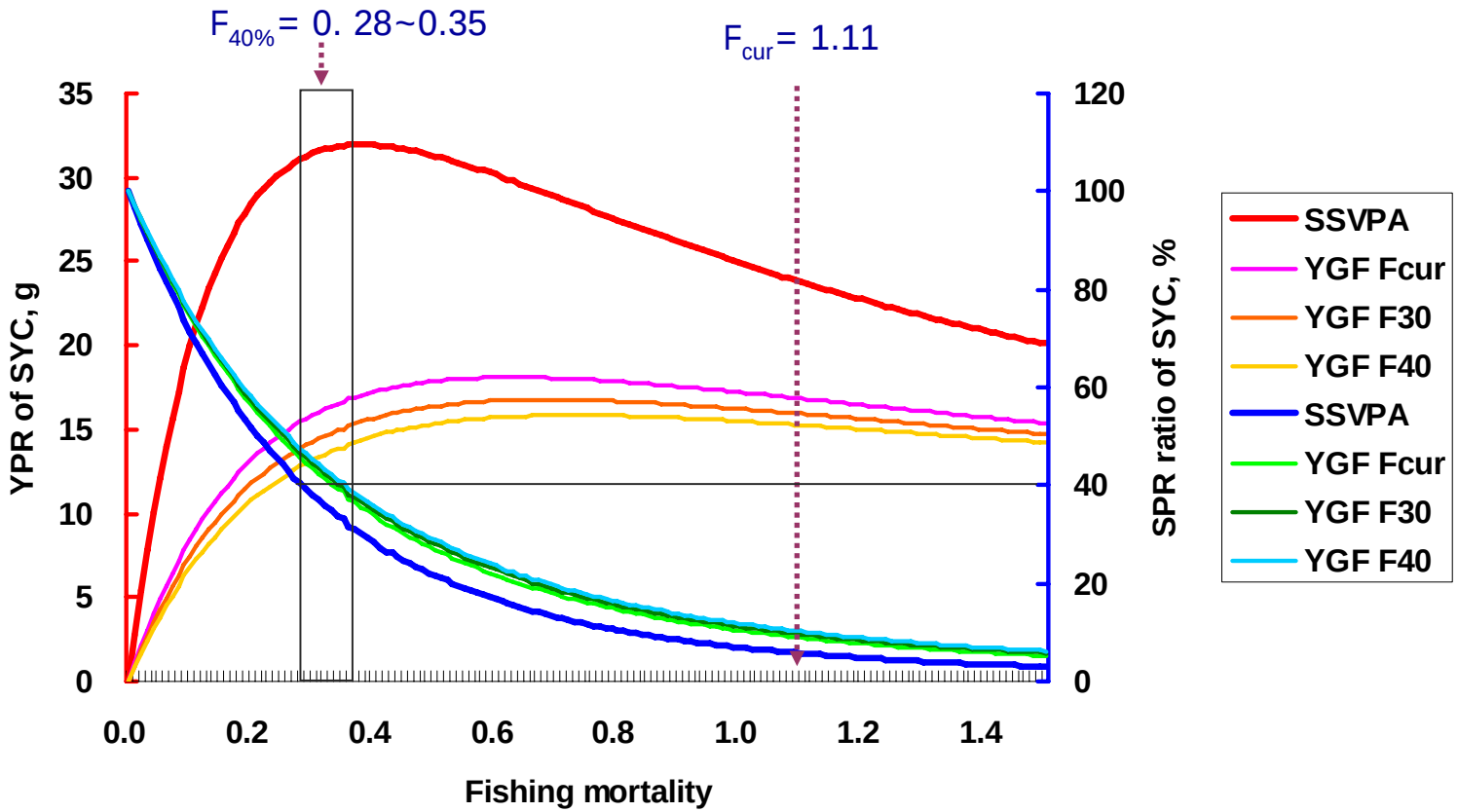




Age-0 small yellow croaker was the highest consumed by yellow goosefish.

Over 80% of small yellow croaker at ages 0-2 were predated by yellow goosefish.

Reference point of small yellow croaker considering yellow goosefish predation



Conclusions

- Adult population sizes are comparable in single species and multispecies models.
- Most predation mortality of SYC occurs in age 0 to 2.
- Predation impact by yellow goosefish on small yellow croaker was considerable.
- Two species management application can be applicable, although the fishing pressures to both species (SYC, YG) need to be reduced in the ECS.