WCPFC
MANAGEMENT OBJECTIVES WORKSHOP

Manila, Republic of the Philippines
28-29 November 2012

CHARACTERISTICS OF HISTORICAL POPULATION DYNAMICS OF TEMPERATE TUNAS IN THE NORTH PACIFIC AND IMPLICATIONS FOR MANAGEMENT

MOW1-PRES/12
28 Nov 2012

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Objectives of Three Japanese Documents

- Three Japanese documents regarding reference point (RP) issues are submitted to this workshop.
- We recognize the value of earlier discussions regarding RPs for WCPFC stocks at SC meetings.
- We also believe that it would be valuable to present additional ideas on other RP candidates applicable to the northern stocks of the WCPFC, which have not yet been discussed at the SC meetings.
- In these three documents, the appropriateness of limit RPs based on historical stock status is explored for the northern stocks.

Three documents from Japan (MOW1-DP-01, 02, 03)

- Kurota, H. and M. Kai. Characteristics of historical population dynamics of temperate tunas in the north Pacific and implications for management
- Kanaiwa, M. The estimation strategy of ABC and the management rule of TAC for Japanese coastal fishery stocks.
- Kai, M., H. Okamura, M. Ichinokawa and H. Kurota. Applicability of historically-based limit reference points to northern tuna stocks in the Pacific.

MOW1-DP-01 Rev1

Characteristics of historical population dynamics of temperate tunas in the north Pacific and implications for management

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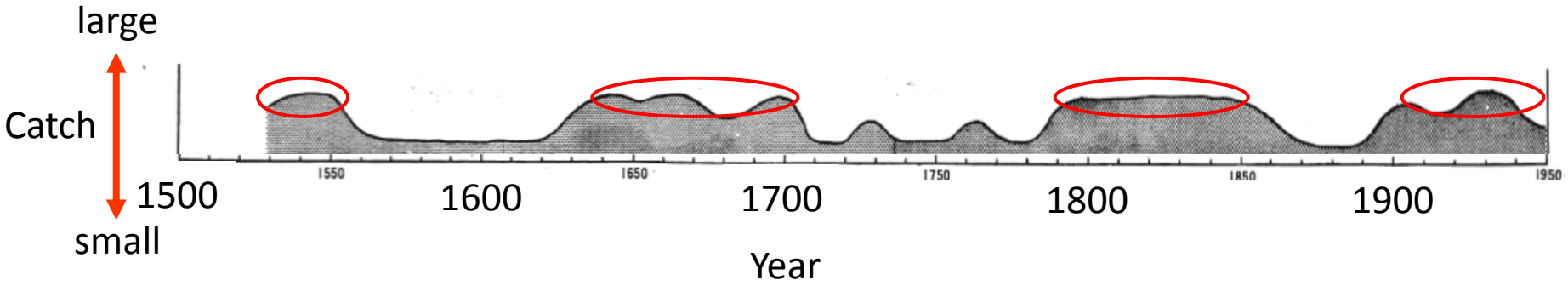
Introduction

- Regarding the definition of "overfished", Hilborn and Stokes (2010) warned that reference points (RPs) based on B_{MSY} and unfished biomass (B_0) are arbitrarily used despite difficulties of interpretation and estimation.
- Instead, they recommend using historical stock sizes as target or limit RPs, because
  1. they are based on species-specific experience;
  2. they are easily understood; and
  3. they are not subject to uncertainties of model assumptions.
- We review the historical stock status of Pacific bluefin (PBF) and northern albacore (ALBN) tunas in the north Pacific.

History of PBF and ALBN Fisheries

- PBF has been exploited for thousands of years as documented by shell mound surveys in Japan.
- Ito (1961) reconstructed long-term catch trends of PBF since the 16th century based on ancient documentation of set nets along the Japanese coast.
  - PBF catch was cyclical with periods of about 100 years.



- ALBN has been caught by US and Japan since the early 20th century (Anderson et al. 1953, Suda 1959).

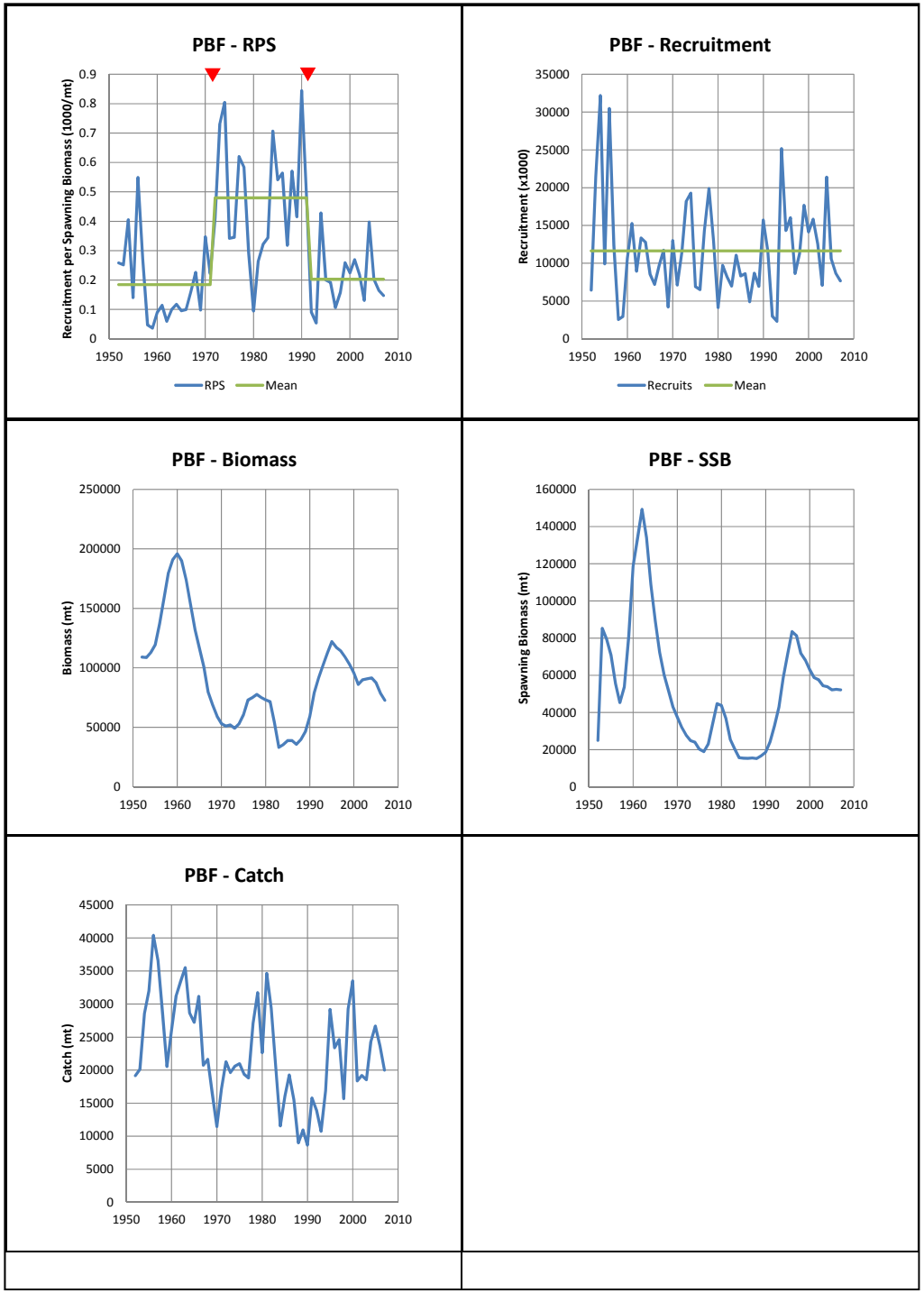
Historical stock status of PBF and ALBN

- Time series of recruitment-related productivity and abundance for 1952-2007 (for PBF) and 1966-2010 (for ALBN) were analyzed.
- Four stock status indices (+ catches) from ISC stock assessments were used:
  1. Recruitment per spawner (RPS)
  2. Recruitment
  3. Total stock biomass
  4. Spawning stock biomass (SSB)
- Regime shifts (long-term variability on the scale of decades) were statistically identified for RPS and recruitment using Rodionov's method (2004, 2006).

2. time-series analysis

PBF

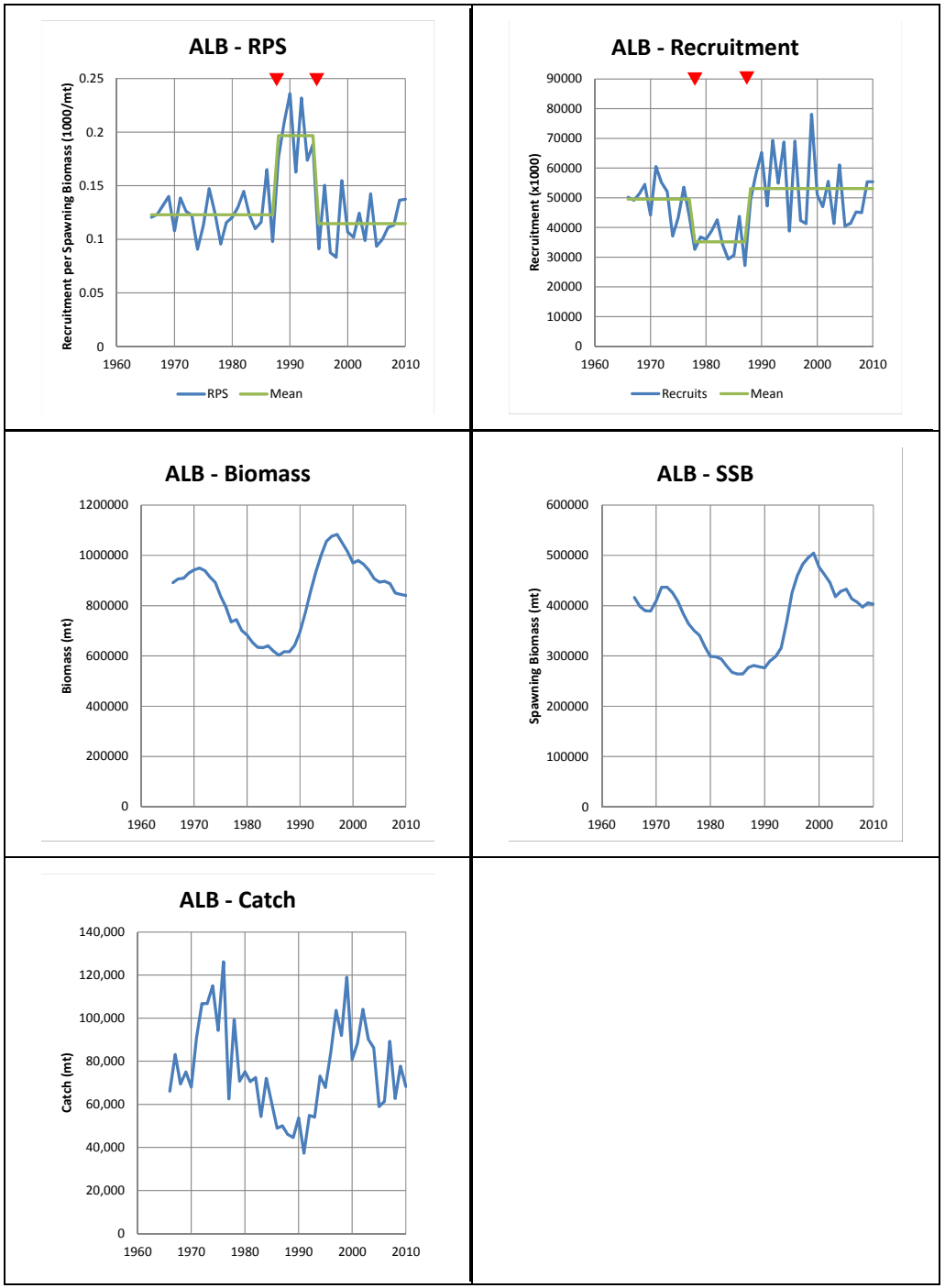
- Decadal fluctuations were apparent in all stock status indices.
- The magnitude of fluctuations including annual variation was large.
- Regime shifts were statistically detected in RPS (in 1972 and 1992).



2. time-series analysis

ALBN

- In most cases, long-term variability over ~20-year cycles was observed.
  - The maxima were ~2-3 times larger than the minima.
- Regime shifts were statistically detected in both RPS (in 1988 and 1995) and recruitment indices (in 1978 and 1988).



Regime shifts

- The timing of regime shifts in recruitment-related productivity closely matched years of climatic regime shifts.
  - Since the 1950s, climatic regime shifts were identified in the North Pacific in 1957-58, 1970-71, 1976-77, and 1988-89.
- This synchronism suggests a considerable influence of the oceanographic environment on productivity and stock status.
  - Inagake and Uehara (2003) showed significant temporal correlations between recruitment and climatic variability indices such as ENSO and PDO.

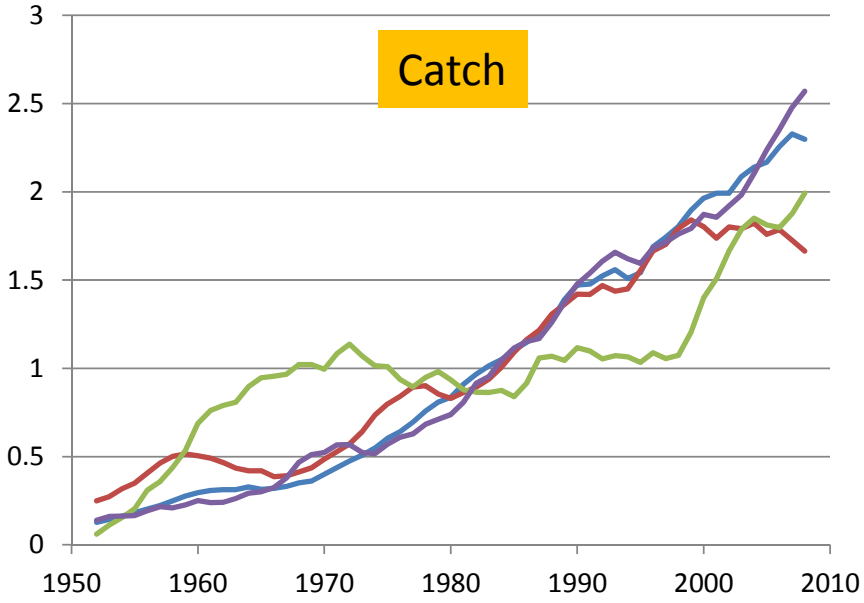
Comparison to tropical tunas and implications for management

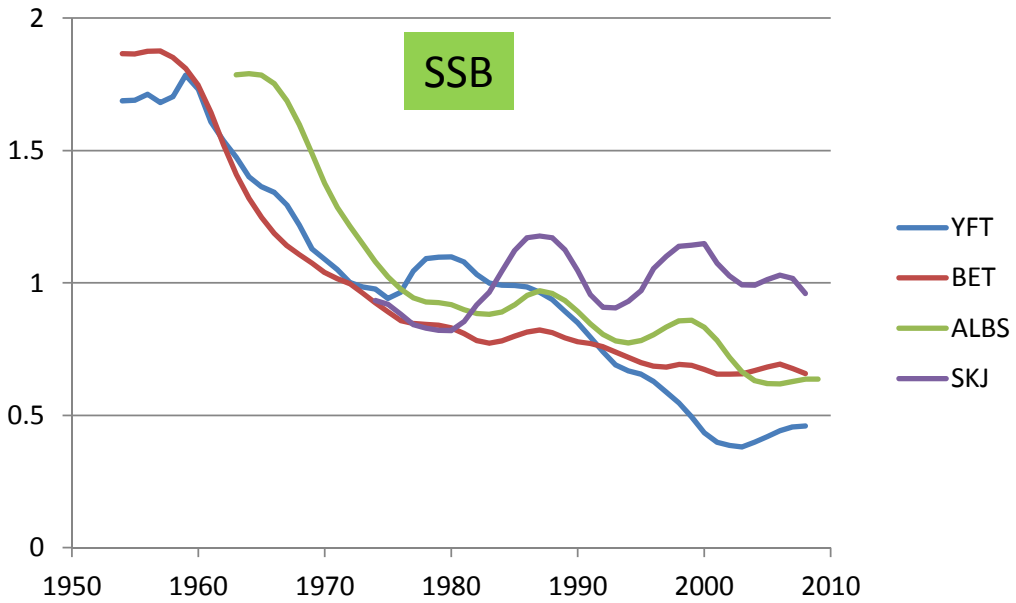
- Features of population dynamics and exploitation history were compared between temperate tunas (PBF and ALB-North) in the north Pacific and tropical tunas (YFT, BET, ALB-South and SKJ) in the western and central Pacific.

3. Differences between temperate and tropical tunas

Tropical tunas

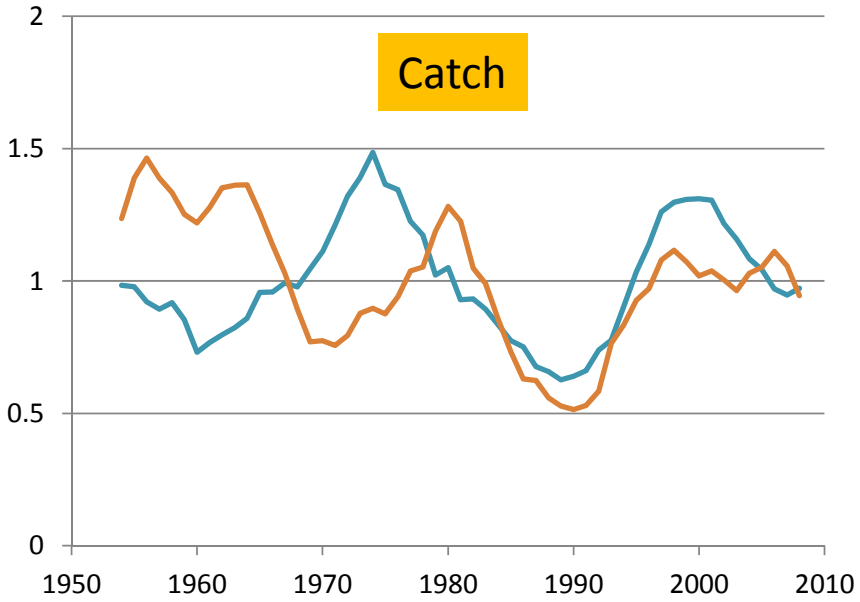
- The history of exploitation is shorter. The fishery developed rapidly with the initiation of the purse seine. Catches of most stocks have been increasing.
- Stock abundance declined consistently ("one-way trip").
- It might be difficult to find a stock level below which "bad things happen" (LRP), because reliable historical information that covers a wide range of stock status is limited.
  - It is reasonable to define LRPs for tropical tunas based on the discussion at SC8.

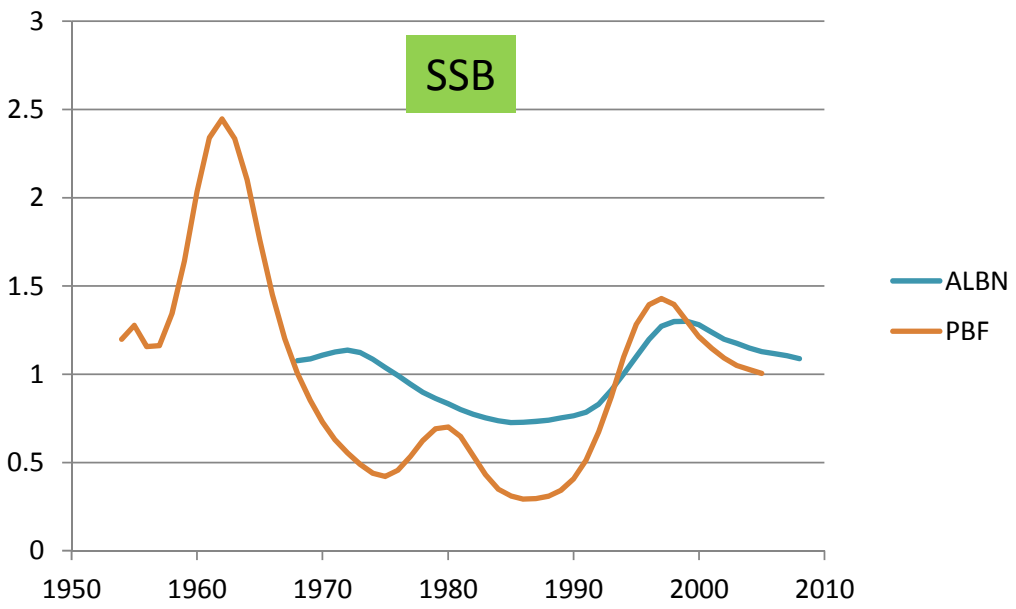




Temperate tunas

- Temperate tunas have a long history of exploitation and catches are relatively stable within a certain range.
- Considerable fluctuations in stock sizes have been identified.
  - Long-term stock status trends could suggest some levels of stock size that would be prudent to avoid.
- It would be reasonable to define LRPs for temperate tunas based on historical stock status.

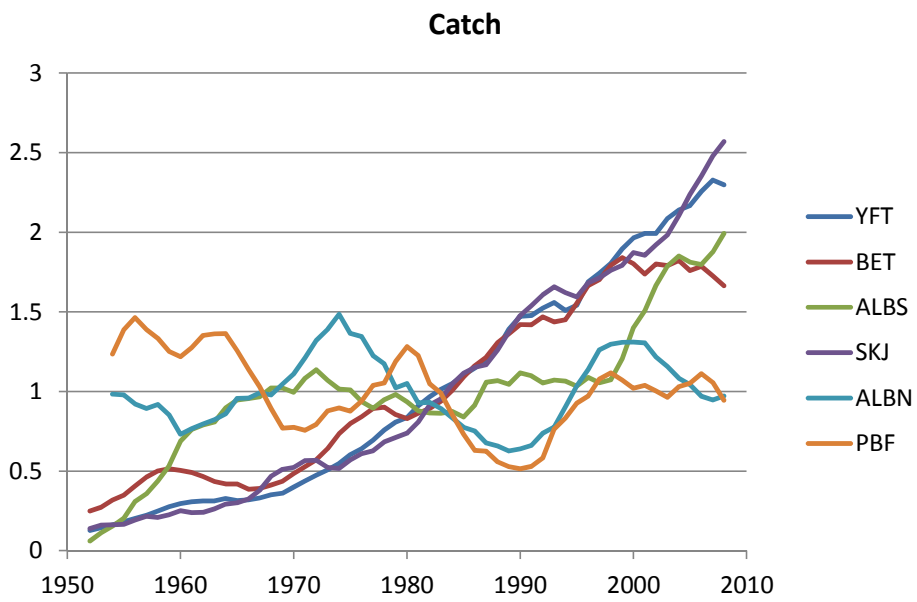




Summary

- Temperate tunas in the North Pacific have different characteristics from tropical tunas in terms of exploitation history and historical population dynamics.
- LRPs based on historical stock sizes can be possible options for temperate tunas in the North Pacific.
- This is also supported from the perspective of ease of management implementation (Kanaiwa 2012) and by theoretical analysis (Kai et al. 2012) .

END


Catch
3
2.5
2
1.5
1
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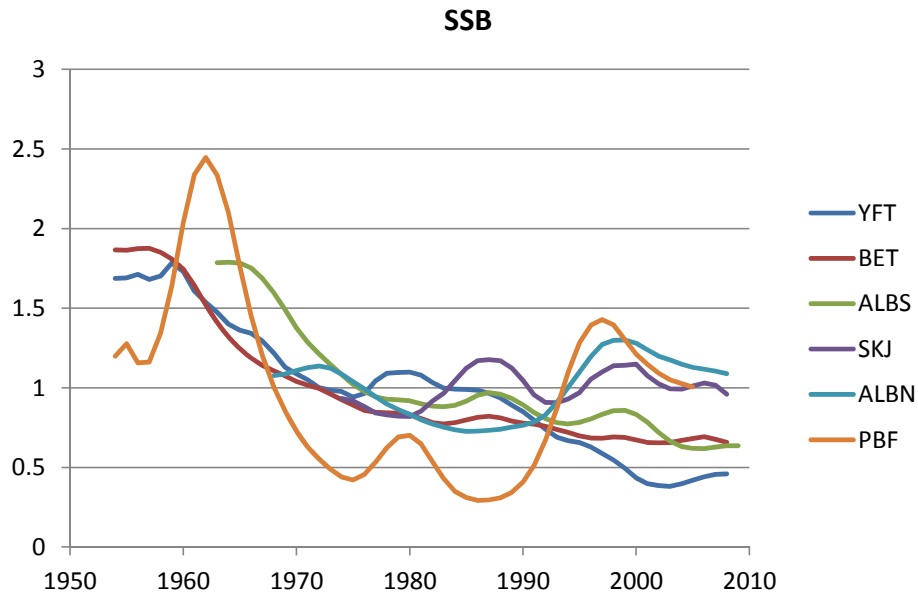
1970
1980
1990
2000
2010
YFT
BET
ALBS
SKJ
ALBN
PBF


SSB
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2
1.5
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YFT
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SKJ
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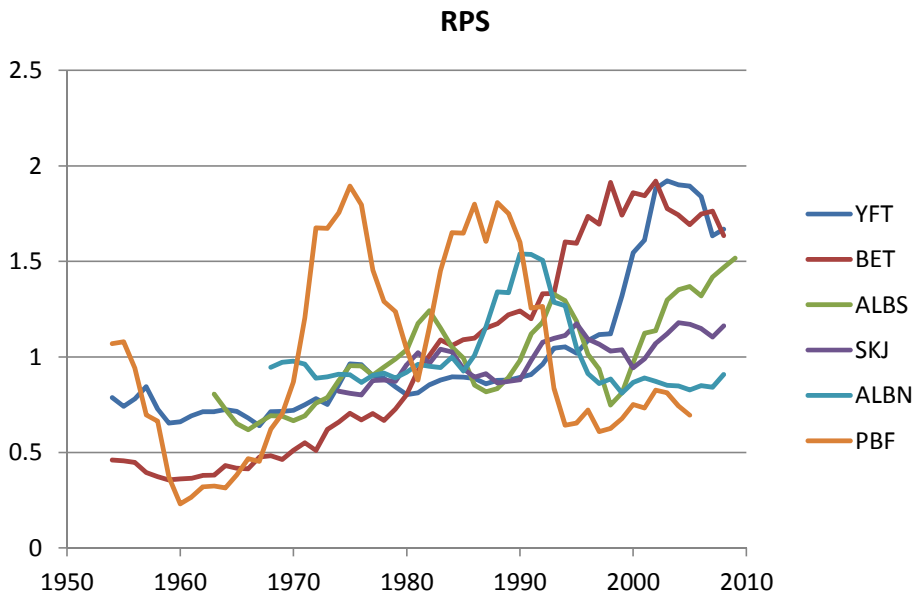
PBF


RPS
2.5
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YFT
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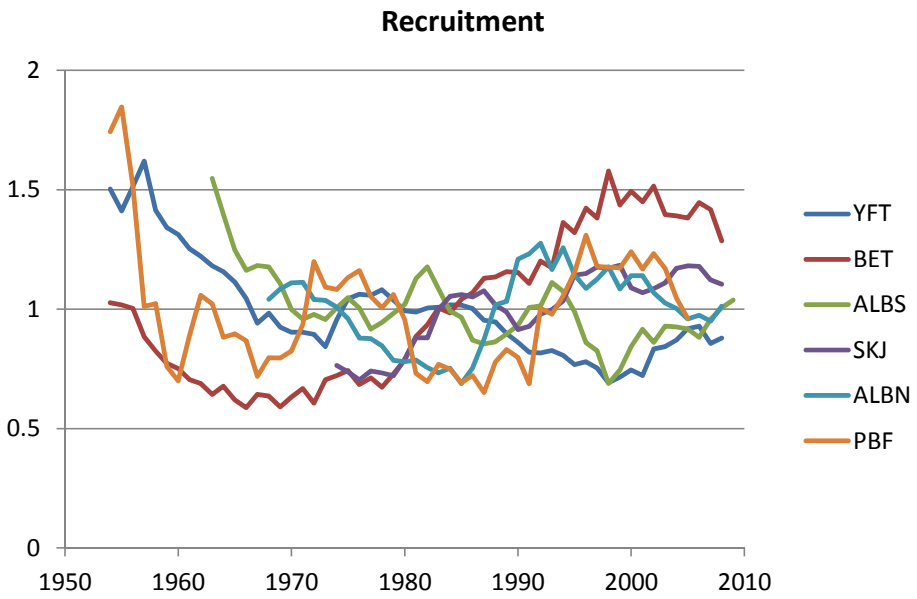
SKJ
ALBN
PBF


Recruitment
2
1.5
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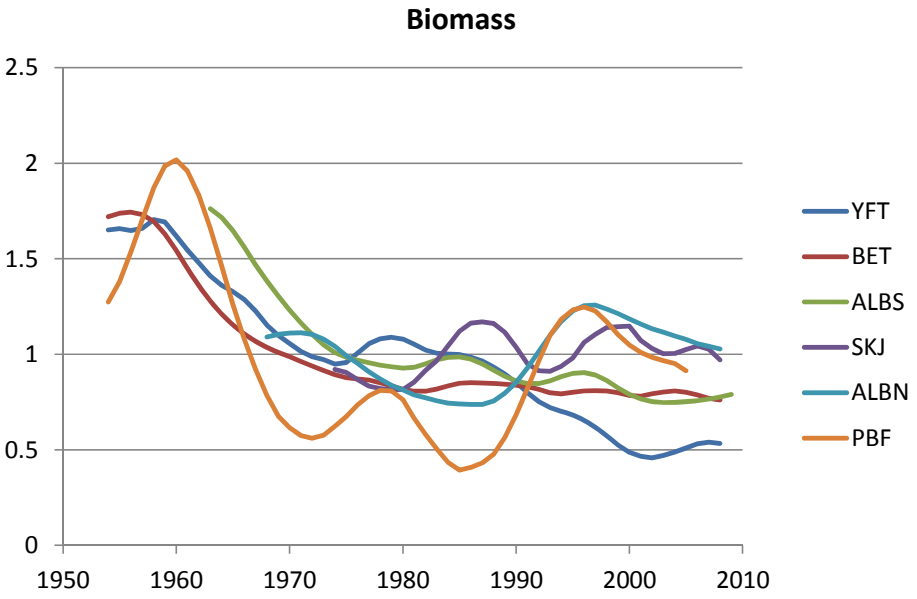
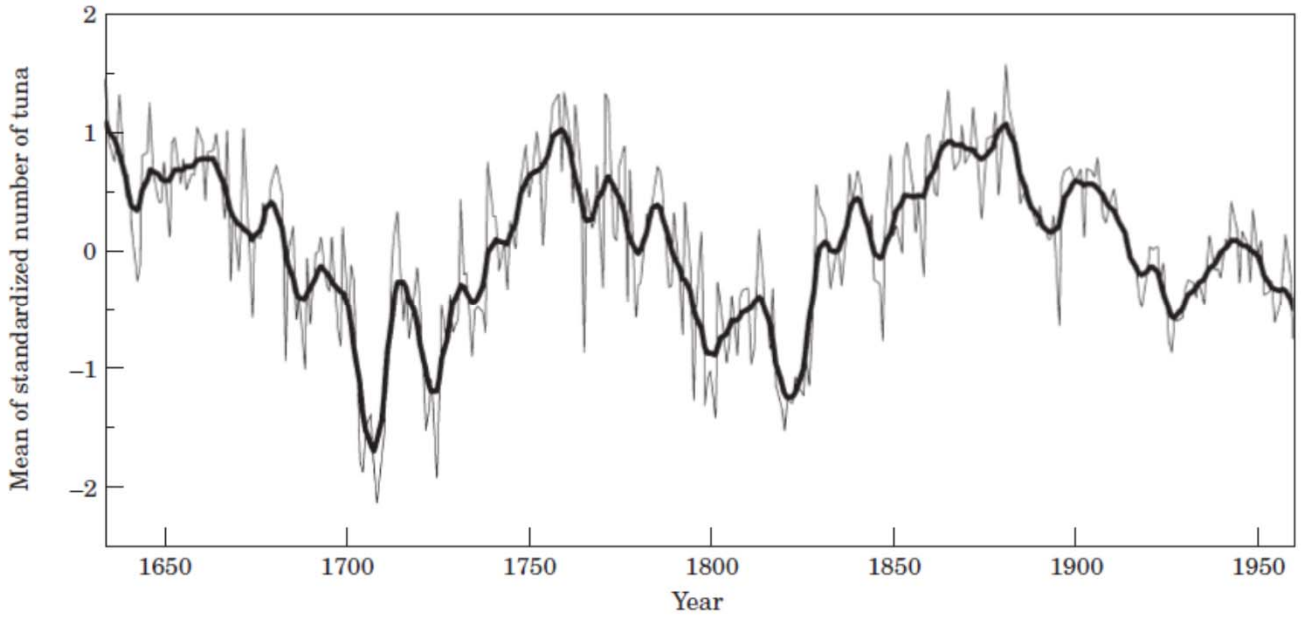
YFT
BET
ALBS
SKJ
ALBN
PBF


Biomass
2.5
2
1.5
1
0.5
0
1950
1960
1970
1980
1990
2000
2010
YFT
BET
ALBS
SKJ
ALBN
PBF

Introduction

- Ocean ecosystem dynamics are influenced by climatic and oceanographic factors as well as fish harvesting.
  - Long-term variability on the scale of decades (regime shifts) has been noted.
- Ravier and Fromentin (2001) analyzed long-term time series of over 300 years for Atlantic bluefin tuna from Mediterranean trap fisheries.
  - Fluctuations of about 15-30 years were found to be superimposed on long-term cycles of about 100-120 years.



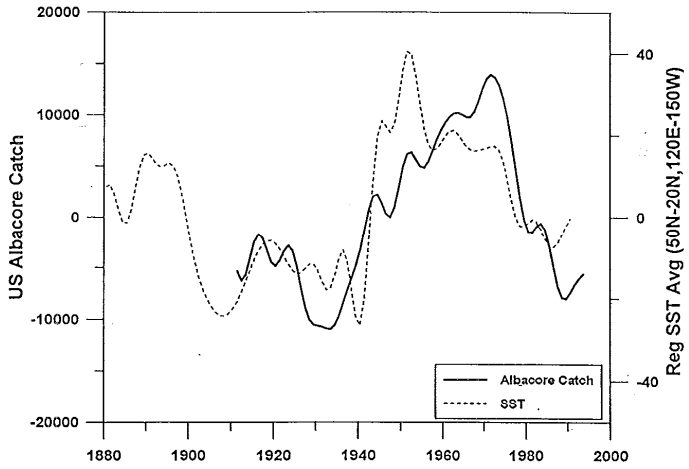
Purpose of this Document

- To review patterns of long-term temporal variability in the stock status of Pacific bluefin (PBF) and northern albacore (ALBN) tunas in the north Pacific, and to characterize them through comparison with tropical tuna species.

1. To review literature that provides information on long-term trends in the stock status of PBF and ALB.
2. To analyze long-term time series of recruitment-related productivity and abundance estimated by ISC stock assessments.
3. To characterize temporal changes in stock status of temperate tunas through comparison with tropical tunas, and to discuss implications for limit reference points (LRPs).

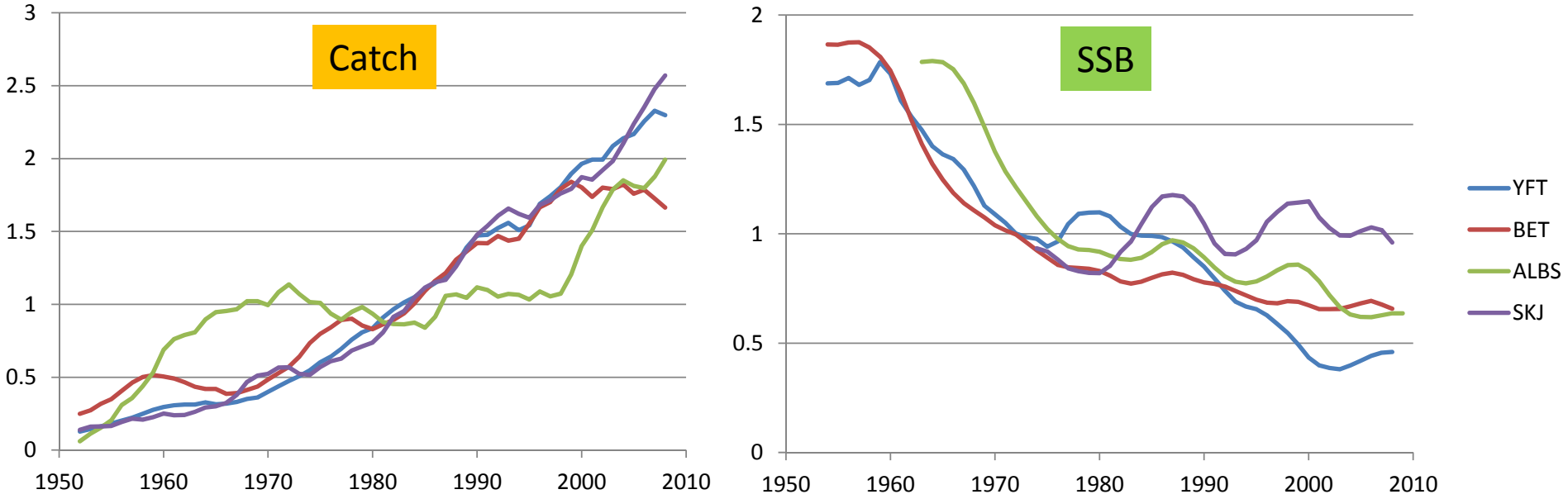
History of ALBN Fishery

- ALBN was caught by US vessels for canning as early as 1903 off southern California (Anderson et al. 1953).
- The Japanese pole-and-line fishery started in the 1920s and annual catches soon exceeded 100,000t (Suda 1959).
- Au and Cayan (1998) analyzed catch records from 1911 to 1993 and showed that catches were associated with decadal-scale climatic changes.
  - Decreasing catch trends were observed during periods of severe winters in the western and central north Pacific.



Tropical tunas

- In this "one-way trip" situation, it might be difficult to find a stock status level below which "bad things happen" (LRP), because reliable historical information that covers a wide range of stock status is limited.
- It might be reasonable to define LRPs for tropical tunas based on the discussion at the WCPFC SC meeting held in Busan (SC8).



Discussion

- LRPs can be regarded as thresholds to avoid recruitment overfishing. For fish stocks with high productivity under low SSB (high *steepness*), recruitment overfishing is very unlikely to occur.
- Temperate tunas in the north Pacific are thus unlikely to suffer from recruitment overfishing, because they are considered to have very high steepness.
- LRPs based on historical stock sizes could play an essential role in the temperate stock management.
- Advantages are also emphasized when considered in terms of management implementation (Kanaiwa 2012) and theoretical analysis (Kai et al. 2012).

Discussion

- A similar approach based on historical stock sizes, $F_{SSB\text{-}ATHL}$ (F to maintain SSB above the average level of the ten historically lowest points) has been used as the interim management objective for the ALBN stock.
- Another LRP called B_{limit} (the minimum stock biomass to ensure an appropriate amount of recruitment) has been officially implemented for Japanese coastal stocks for about 15 years.
- Advantages of these types of LRPs are also emphasized when considered in terms of management implementation (Kanaiwa 2012) and theoretical analysis (Kai et al. 2012).