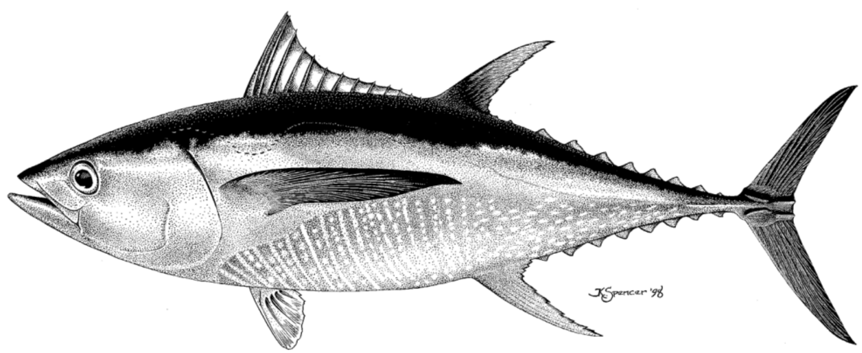
# KOBE STRATEGY MATRIX FOR YELLOWFIN and BIGEYE in the Eastern Pacific Ocean in 2012



CIAT
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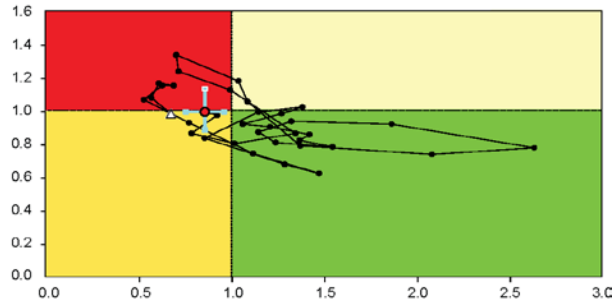
# Introduction

The joint meetings of the tuna regional fisheries management organizations (tRFMOs) recommended *standardization of the stock assessment results for management advice:*

- **Kobe plots:** four quadrants, red-yellow-green format




- **Kobe II strategy matrix**: alternative options for meeting management targets

# Kobe II strategy matrix

- The matrix was computed with FMSY because the IATTC staff recommendations have treated FMSY as a target reference point
- The informal harvest rule used to manage tunas in the EPO has been reducing fishing mortality to FMSY if it exceeds FMSY.

# Methods

- Kobe II strategy matrix:
  - Compute the fraction of the current fishing mortality ($F_{cur}$) that is required to ensure a given probability $P$ that it will be at or below fishing mortality target reference point
  - Normal approximation for computing the probabilities
- Decision table for biomass reference points

# Kobe II strategy matrix for yellowfin
## in the EPO in 2012

Table 1

| Proposed reference point | State of nature steepness | Variability | Fraction of the current (2010-2012) fishing mortality required to ensure the following probability of being below the target or limit | | | |
|---|---|---|---|---|---|---|
| | | | **95%** | **90%** | **80%** | **50%** |
| **Target $F = F_{MSY}$** | Base case | Low | 0.972 | 0.980 | 0.991 | 1.010 |
| | | High | 0.906 | 0.929 | 0.957 | 1.010 |
| | h = 0.75 | Low | 0.604 | 0.613 | 0.624 | 0.644 |
| | | High | 0.578 | 0.592 | 0.610 | 0.644 |
| **Limit $F = 1.4 F_{MSY}$** | Base case | Low | 1.361 | 1.372 | 1.381 | 1.415 |
| | | High | 1.269 | 1.301 | 1.323 | 1.415 |
| | h = 0.75 | Low | 0.809 | 0.829 | 0.854 | 0.902 |
| | | High | 0.846 | 0.858 | 0.873 | 0.902 |

# Kobe II strategy matrix for bigeye

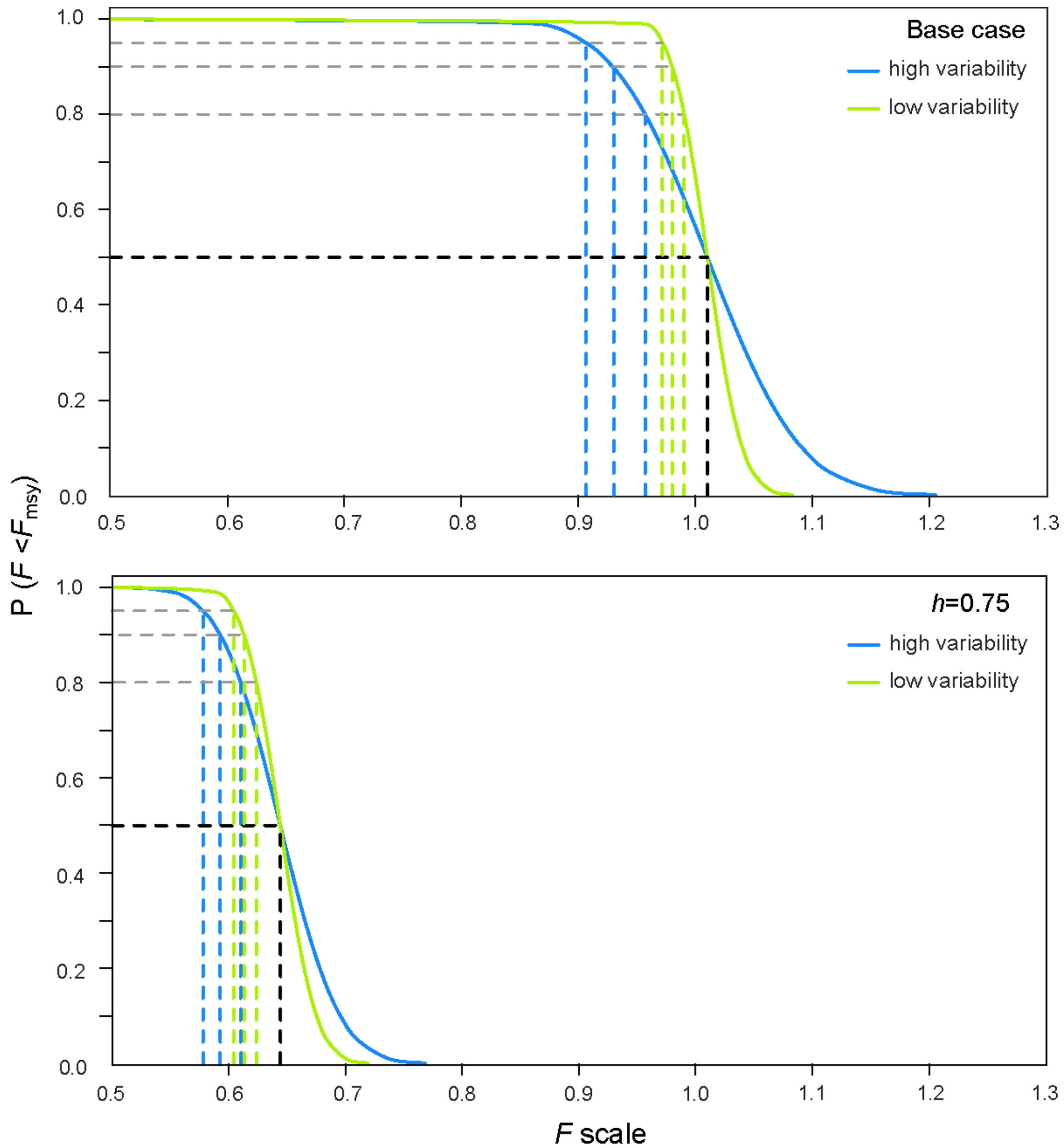
## in the EPO in 2012

Table 2

| Proposed reference point | State of nature steepness | Fraction of the current (2010-2012) fishing mortality required to ensure the following probability of being below the target or limit | | | |
|---|---|---|---|---|---|
| | | **95%** | **90%** | **80%** | **50%** |
| **Target $F = F_{MSY}$** | Base case | 0.899 | 0.933 | 0.974 | 1.053 |
| | h = 0.75 | 0.713 | 0.738 | 0.767 | 0.825 |
| **Limit $F = 1.3\ F_{MSY}$** | Base case | 1.168 | 1.213 | 1.266 | 1.369 |
| | h = 0.75 | 0.927 | 0.959 | 0.998 | 1.072 |

# Risk curves for yellowfin

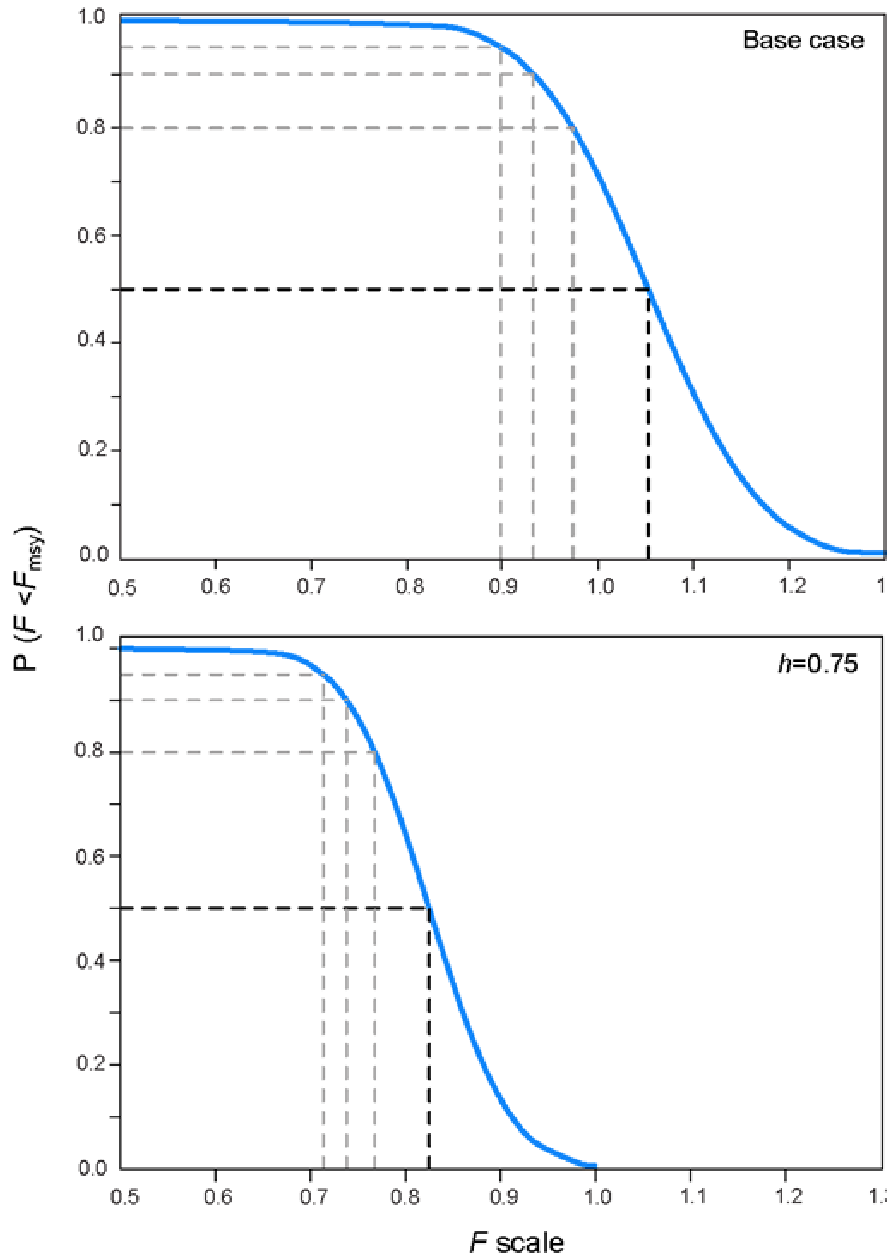
Probability that the fishing mortality ($F$) is below the level corresponding to MSY ($F_{MSY}$)




fractions (δ = *F scale*) of the current fishing mortality (2010-2012).

# Risk curves for bigeye

Probability that the fishing mortality ($F$) is below the level corresponding to MSY ($F_{MSY}$)




fractions (δ = *F scale*) of the current fishing mortality (2010-2012).

# Decision table for yellowfin in the EPO in 2012

## Biomass reference points

Table 3

| Proposed reference point | State of nature steepness | Time frame (years) | Probability of being above the target or limit by fishing at | |
|---|---|---|---|---|
| | | | $F_{cur}$ | $F_{MSY}$ |
| target $S = S_{MSY}$ | Base case | 0 | 0.082 | 0.082 |
| | | 5 | 0.519 | 0.500 |
| | | 10 | 0.520 | 0.500 |
| | h = 0.75 | 0 | 0.000 | 0.000 |
| | | 5 | 0.000 | 0.221 |
| | | 10 | 0.000 | 0.481 |
| limit $S = 0.4\ S_{MSY}$ | Base case | 0 | 1 | 1 |
| | | 5 | 0.996 | 0.997 |
| | | 10 | 0.996 | 0.997 |
| | h = 0.75 | 0 | 1 | 1 |
| | | 5 | 0.832 | 0.992 |
| | | 10 | 0.897 | 0.996 |

$F_{cur}$ is the average fishing mortality for the last three years in the current assessment (2010-2012)

# Decision table for yellowfin in the EPO in 2012

## Fishing mortality reference points

Table 4

| Proposed reference point | State of nature steepness | Variability | Probability of being below the target or limit by fishing at $F_{cur}$ |
|---|---|---|---|
| Target $F = F_{MSY}$ | Base case | low | 0.671 |
| | | high | 0.565 |
| | h = 0.75 | low | 0 |
| | | high | 0 |
| Limit $F = 1.4\ F_{MSY}$ | Base case | low | 1 |
| | | high | 1 |
| | h = 0.75 | low | 0.002 |
| | | high | 0.041 |

# Decision table for bigeye in the EPO in 2012

## Biomass reference points

Table 5

| Proposed reference point | State of nature steepness | Time frame (years) | Probability of being above the target or limit by fishing at | |
|---|---|---|---|---|
| | | | $F_{cur}$ | $F_{MSY}$ |
| target $S = S_{MSY}$ | Base case | 0 | 0.794 | 0.794 |
| | | 5 | 0.485 | 0.349 |
| | | 10 | 0.579 | 0.488 |
| | h = 0.75 | 0 | 0.259 | 0.259 |
| | | 5 | 0.125 | 0.124 |
| | | 10 | 0.179 | 0.333 |
| limit $S = 0.5\ S_{MSY}$ | Base case | 0 | 0.998 | 0.998 |
| | | 5 | 0.904 | 0.995 |
| | | 10 | 0.931 | 1 |
| | h = 0.75 | 0 | 0.997 | 0.997 |
| | | 5 | 0.808 | 0.981 |
| | | 10 | 0.796 | 1 |

$F_{cur}$ is the average fishing mortality for the last three years in the current assessment (2010-2012)

# Decision table for bigeye in the EPO in 2012

## Fishing mortality reference points

Table 6

| Proposed reference point | State of nature steepness | Probability of being below the target or limit by fishing at $F_{cur}$ |
|---|---|---|
| **Target** $F = F_{MSY}$ | Base case | 0.714 |
| | h = 0.75 | 0.005 |
| **Limit** $F = 1.3\ F_{MSY}$ | Base case | 0.999 |
| | h = 0.75 | 0.793 |

$F_{cur}$ is the average fishing mortality for the last three years in the current assessment (2010-2012)

# Misspecification cases: yellowfin

Biomass reference points

Table 7

| Steepness | | Proposed reference point | Probability of being above the reference point in | | |
|---|---|---|---|---|---|
| True state of nature | Assessment assumption | | 0 years | 5 years | 10 years |
| h = 0.75 | h = 1 ($F_{mult}$ = 1.01) | target $S = S_{MSY}$ | 0 | 0 | 0 |
| | | limit $S = 0.4\ S_{MSY}$ | 1 | 0.838 | 0.905 |
| Base case | h = 0.75 ($F_{mult}$ = 0.64) | target $S = S_{MSY}$ | 0.082 | 0.952 | 0.952 |
| | | limit $S = 0.4\ S_{MSY}$ | 1 | 1 | 1 |

Fishing mortality RP

Table 8

| Steepness | | Variability | Probability of being below | |
|---|---|---|---|---|
| True state of nature | Assessment assumption | | target $F = F_{MSY}$ | Limit $F = 1.4\ F_{MSY}$ |
| h = 0.75 | h = 1 ($F_{mult}$ = 1.01) | low | 0 | 0.007 |
| | | high | 0 | 0.027 |
| Base case | h = 0.75 ($F_{mult}$ = 0.64) | low | 1 | 1 |
| | | high | 1 | 1 |

# Misspecification cases: bigeye

Biomass reference points

Table 9

| Steepness | | Proposed reference point | Probability of being above the reference point in | | |
|---|---|---|---|---|---|
| True state of nature | Assessment assumption | | 0 years | 5 years | 10 years |
| h = 0.75 | h = 1 ($F_{mult}$ = 1.05) | target $S = S_{MSY}$ | 0.259 | 0.012 | 0.004 |
| | | limit $S = 0.5\ S_{MSY}$ | 0.997 | 0.912 | 0.940 |
| Base case | h = 0.75 ($F_{mult}$ = 0.82) | target $S = S_{MSY}$ | 0.794 | 0.799 | 0.971 |
| | | limit $S = 0.5S_{MSY}$ | 0.998 | 0.999 | 1 |

Fishing mortality RP

Table 10

| Steepness | | Probability of being below | |
|---|---|---|---|
| True state of nature | Assessment assumption | target $F = F_{MSY}$ | limit $F = 1.3\ F_{MSY}$ |
| h = 0.75 | h = 1 ($F_{mult}$ = 1.05) | 0.0004 | 0.598 |
| Base case | h = 0.75 ($F_{mult}$ = 0.82) | 0.993 | 1 |

# Conclusions

**Biomass limit reference points:**

- For both stocks there is a high probability of being above the proposed biomass limit reference points

**Fishing mortality limit reference points:**

- Bigeye: Reduce Fcur by 4% to have a P(Fcur< 1.3 FMSY) =90%
- Yellowfin: Reduce Fcur by 14% top 17% to have a P(Fcur< 1.4 FMSY) =90%

**Target Reference points:**

- Bigeye – if the steepness in 0.75 and F=FMSY the population will not rebuild to SMSY within 10 years.

**Mispecification:**

- Our results indicates that there may be an inconsistency between these fishing mortality and biomass limit reference points

# Conclusions

## Computation of the the Kobe II Strategy Matrix:

- Calculations for fishing mortality reference points are less computationally demanding than those for biomass reference points, which is convenient since the informal decision rule used to manage tuna in the EPO is based on fishing mortality.
- Other model structure uncertainty and mispecification (e.g. natural mortality and the average length of old individuals) should also be included in the evaluation of the Kobe II Strategy Matrix and limit reference points.

## A form of management strategy evaluation (MSE)

- The analyses presented in this report evaluates the current informal harvest control rule used for managing tunas in the EPO (i.e. set the fishing mortality at $F_{MSY}$).
- We evaluated the harvest control rule under different states of nature through two assumptions about the steepness of the stock-recruitment relationship.
- This MSE should be extended to include additional states of nature. Other harvest control rules could also be evaluated.

Thank you!