The framework of the management strategy evaluation for dolphinfish in the northwest Pacific Ocean

Sheng-Ping Wang, Wen-Qi Xu, Chih-Yu Lin

Department of Environmental Biology and Fisheries Science, National Taiwan Ocean University, Keelung 20224, Taiwan.

Management objective:

1. The MSY-based reference points are adopted to set the target and limit reference points (target reference point, TRP: SSBMSY and FMSY; limit reference point, LRP: 0.5*SSBMSY and 1.5*FMSY).
2. The management objective is to have a high probability that spawning stock biomass and fishing mortality can achieve the target level (green quadrant of Kobe plot) in 2037.
3. The total allowable catch (TAC) is tuned every 3 years for future projection (TAC block).
4. The framework of the management strategy (MSE) is shown in Fig. 1.

Operating model:

1. The operating model (OM) is developed using Stock Synthesis (SS) with population and fishery-related parameters estimated by SS with historical catch, CPUE and length composition data.
2. The uncertainty of estimated parameters is considered using bootstrap or MCMC methods when estimating parameters by SS with historical data.
3. The uncertainty of simulated data is considered using a bootstrap method.
4. The CPUE from OM and catches by fisheries from harvest control rule (HCR) are generated for future projection, while length composition data are not considered.

Management procedure:

1. The assessment model is also developed using SS, which is a simplified model for not estimating the recruitment deviations for the future population because length composition data are not generated from OM.
2. Log-normal distributed random variable with 0 mean and a specified variation is used for the recruitment deviations for the future population.
3. A 20% variation is used between the TAC block.

4. A 10% of implementation error is used for TAC.

Harvest control rule:

1. A model-based HCR is used based on the settings of TRP, LRP and catch levels corresponding to these two reference points (Fig. 2).
2. HCR is designed to calculate the catches based on the depletion of spawning biomass (SSB/SSBMSY) estimated by the assessment model.
3. Four HCR are developed for preliminary trials:
   (1) HCR1 : Cmax = 1.0*MSY ; Cmin= 0.5*MSY
   (2) HCR2 : Cmax = 1.0*MSY ; Cmin= 0.2*MSY
   (3) HCR3 : Cmax = 0.9*MSY ; Cmin= 0.5*MSY
   (4) HCR4 : Cmax = 0.9*MSY ; Cmin= 0.2*MSY

Results of preliminary trials:

1. The results of preliminary trials based on h=0.7 are shown below as examples.
2. The historical quantities related to population dynamics and fisheries exploitation estimated by the assessment model are very close to those obtained from the operating model (Fig. 3).
3. The results of preliminary trials reveal increasing patterns for future catches since an optimistic stock status is obtained from the current assessment (Fig. 4).
4. However, the probabilities of the future stock status lying in the non-green zone of the Kobe plot obviously increased when the steepness of the stock-recruitment relationship decreased.
5. Based on the performance indices, increasing Cmin or decreasing Cmax can lead to a higher probability of achieving the target level (green quadrant of Kobe plot) and can maintain higher biomass and lower fishing levels, but the long-term catch is also reduced. The stabilities of catch level are not obviously different among HCRs (Fig. 5).

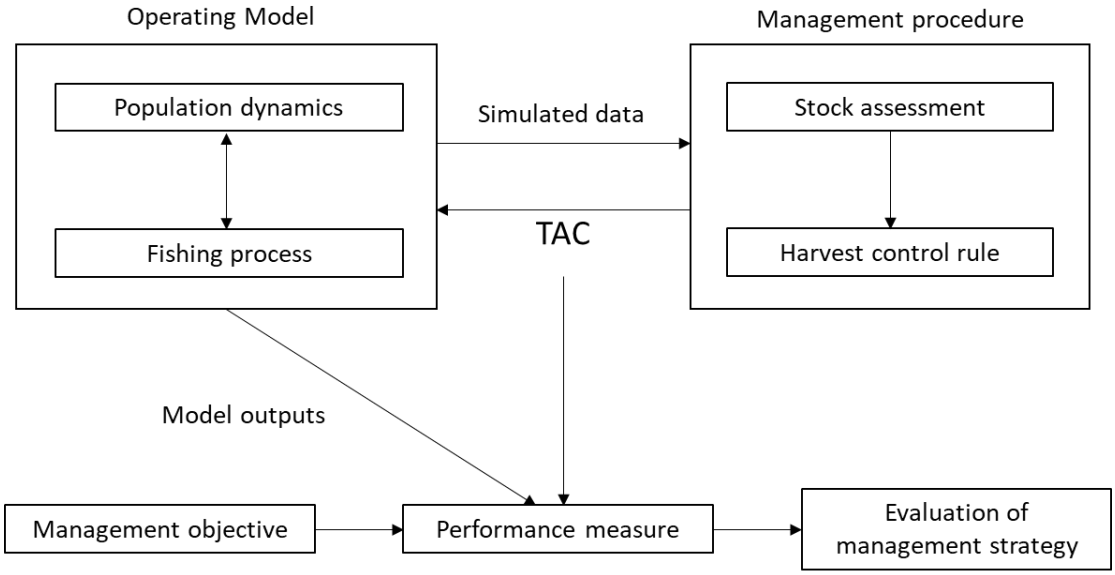

Fig. 1. Framework of the management strategy evaluation for dolphinfish in the northwest Pacific Ocean.

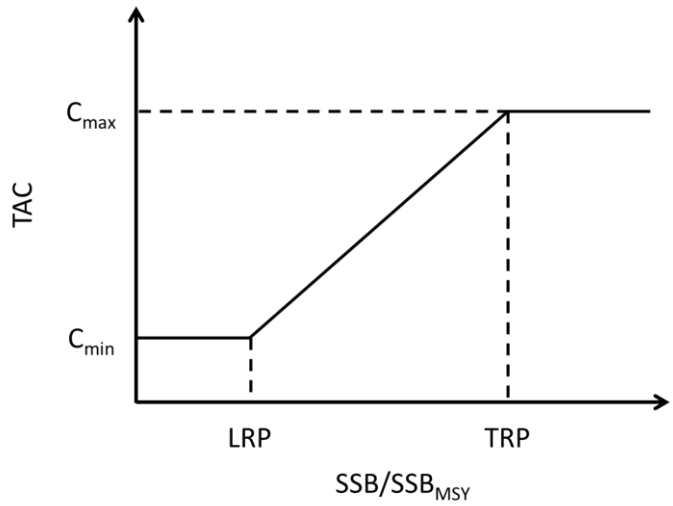

Fig. 2. Harvest control rule for dolphinfish caught by fisheries in the northwest Pacific Ocean.

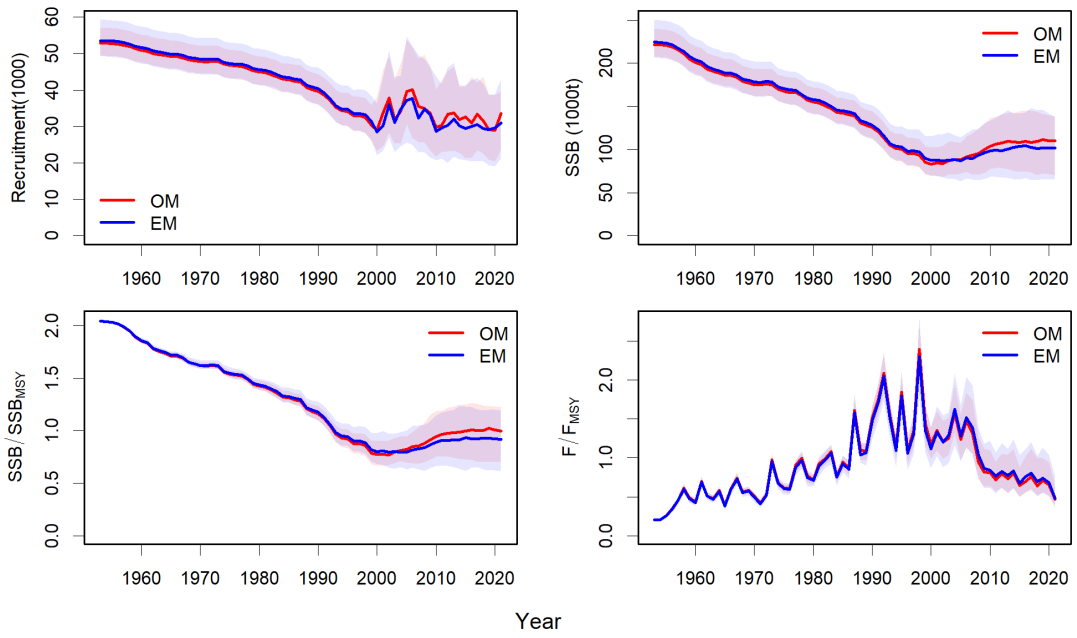

Fig. 3. Historical quantities related to population dynamics and fisheries exploitation estimated by the assessment and operating models.

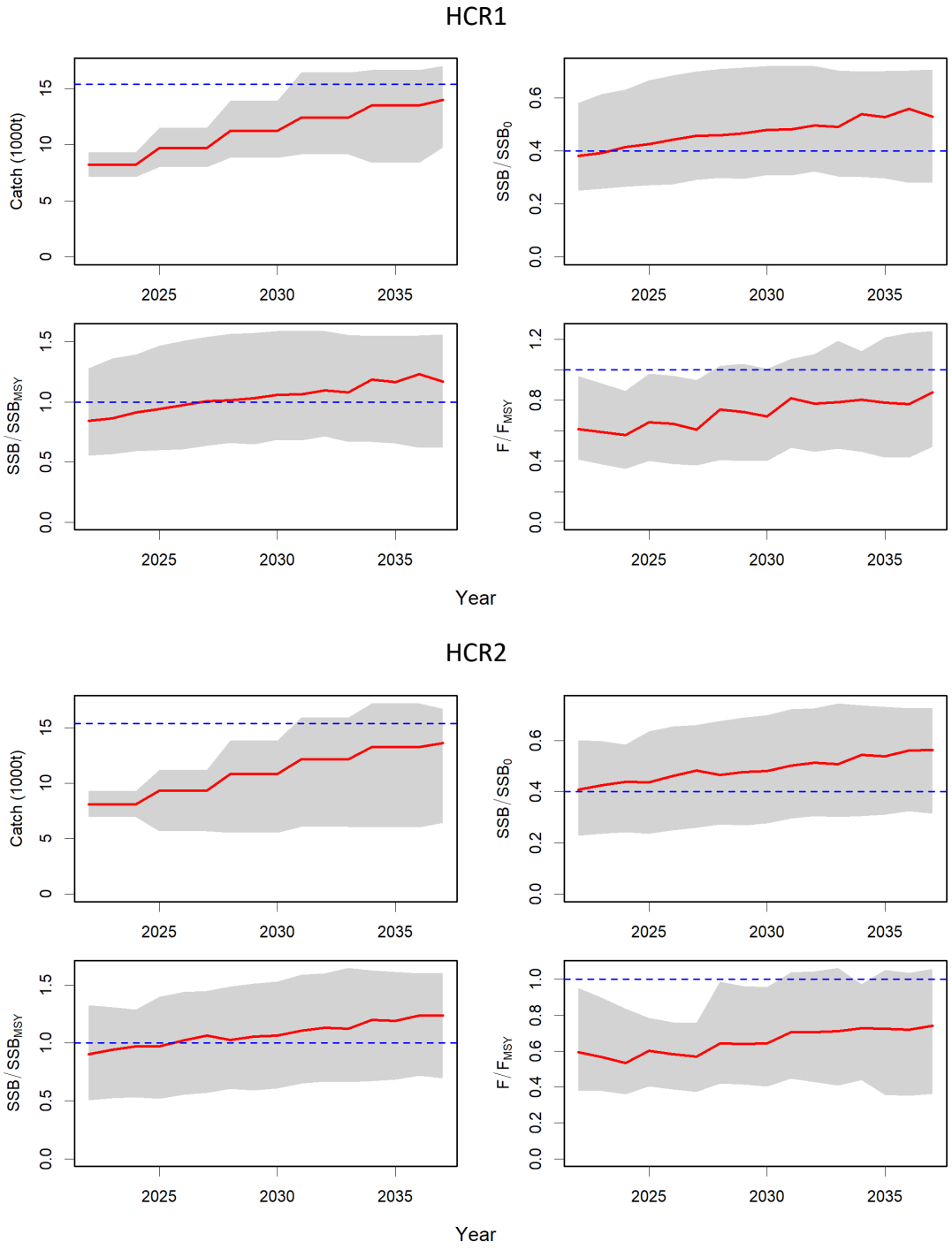

Fig. 4. Trajectories of catch, spawning stock biomass and fishing mortality for the future projection.

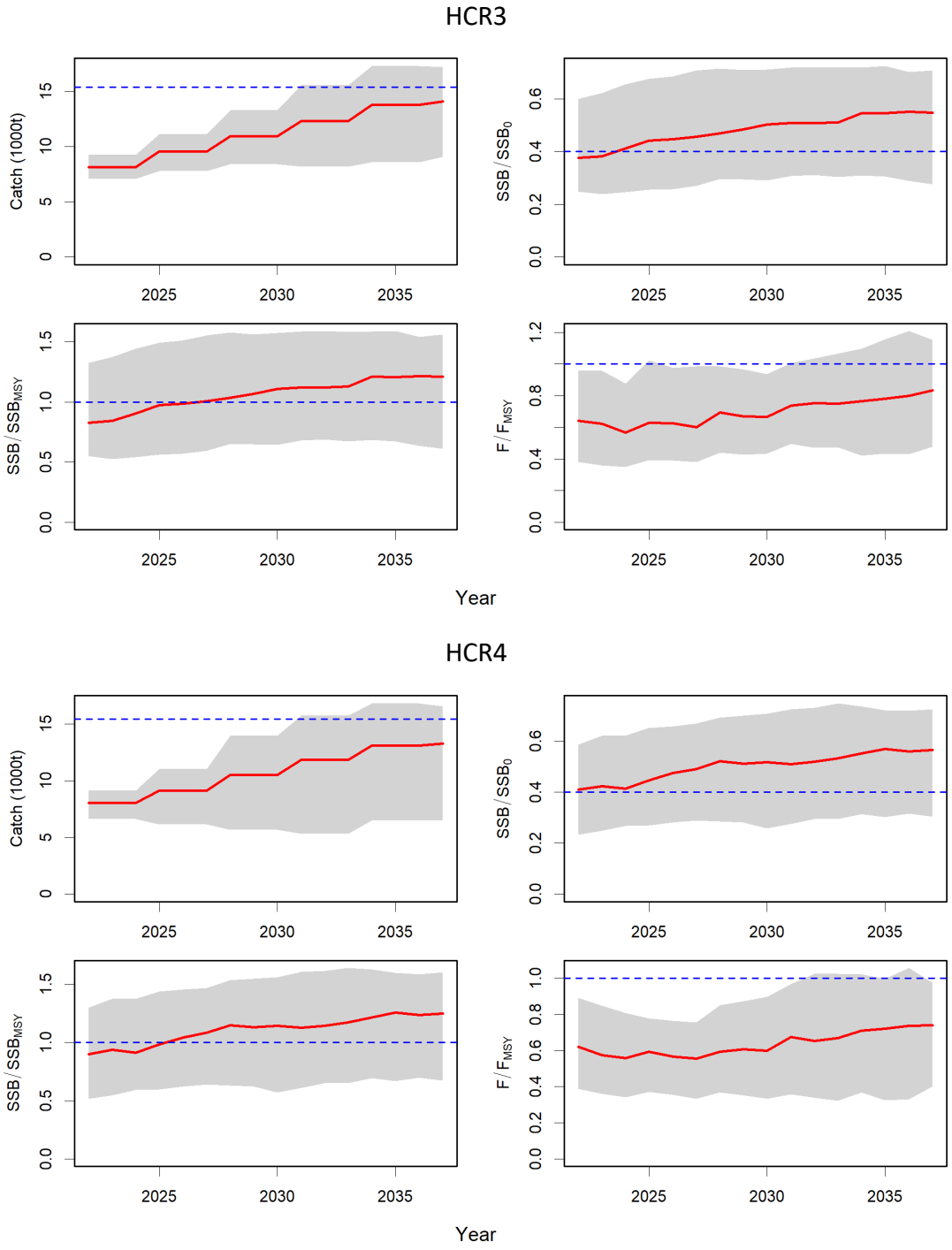

Fig. 4. (continued).

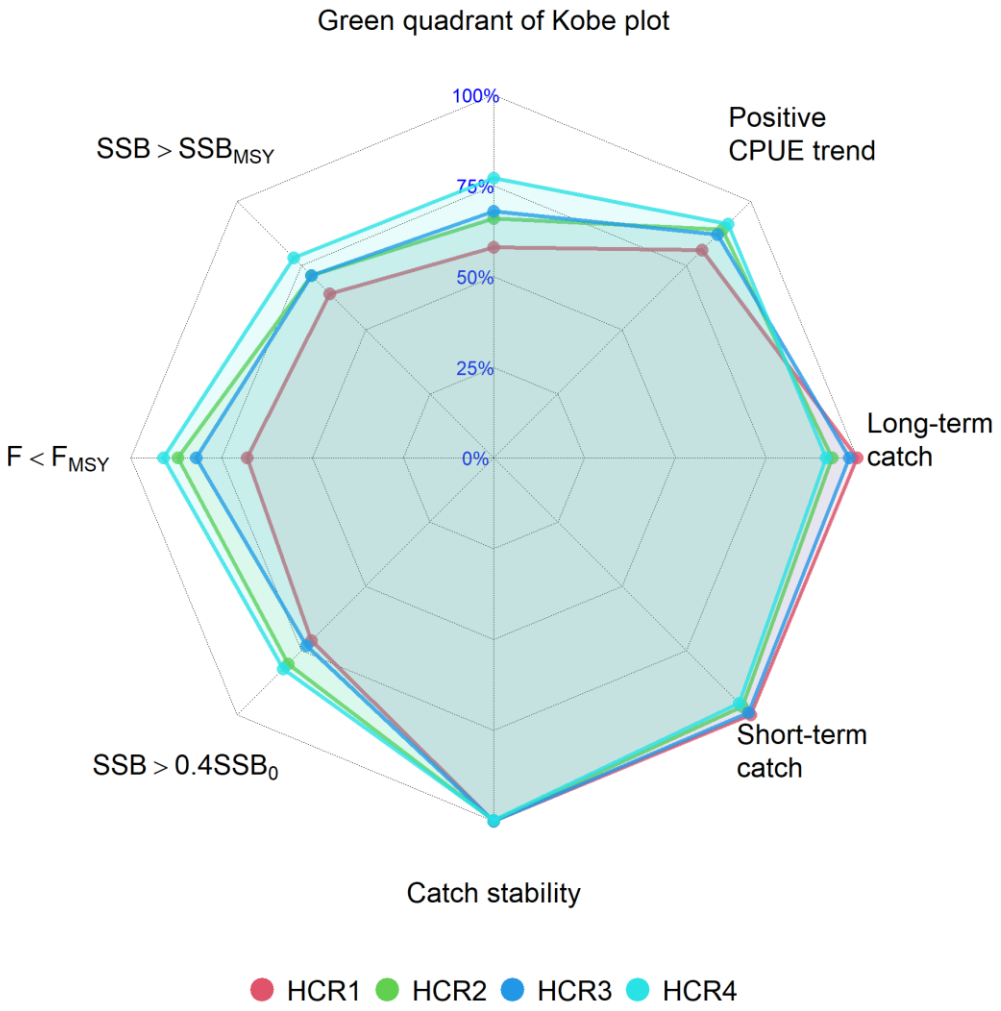

Fig. 5. Diagram of performance indices for management strategy evaluation based on various harvest control rules.