



Using Management Strategy Evaluation to Investigate the Effects of Fishing and the Environment on Pacific Halibut

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PURPOSE

This document provides an electronic version of a brochure presenting Management Strategy Evaluation (MSE) simulations to examine environmental and fishing effects on Pacific halibut.

BACKGROUND

After presenting to the MSAB at MSAB019 the results of simulations examining the effects of low and high average recruitment tied to environmental conditions, they requested that outreach materials be developed.

[IPHC-2024-MSAB019-R](#), para 32: The MSAB **REQUESTED** that outreach materials be developed by the Secretariat that synthesize the effect of the PDO (e.g. via recruitment) on the coastwide and regional stock dynamics and the relative effect of fishing in simple terms with interpretation and consequences of the outcomes.

Appendix I shows an electronic version of a brochure describing these results. The simulations hold average recruitment constant at low or high values while weight-at-age is allowed to vary randomly over the projection period.

APPENDICES

Appendix I: An electronic version of a brochure presenting Management Strategy Evaluation simulations to investigate the effects of fishing and the environment on Pacific halibut.

Appendix I

An electronic version of a brochure presenting Management Strategy Evaluation simulations to investigate the effects of fishing and the environment on Pacific halibut.

INTERNATIONAL PACIFIC

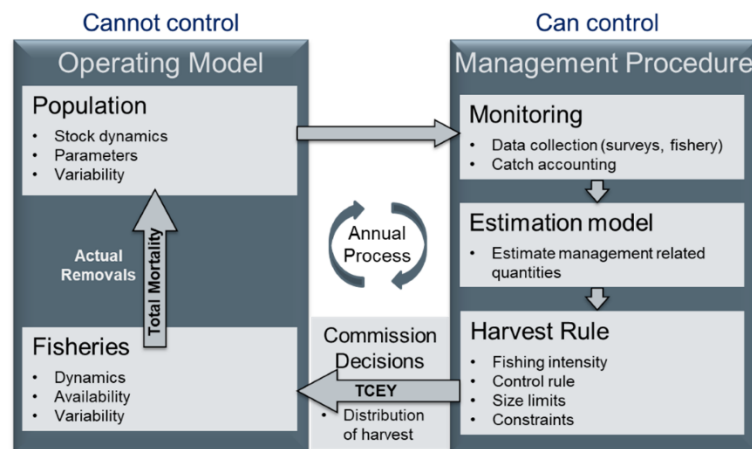


HALIBUT COMMISSION

**USING MANAGEMENT STRATEGY EVALUATION TO
INVESTIGATE THE EFFECTS OF FISHING AND THE
ENVIRONMENT ON PACIFIC HALIBUT**



INTERNATIONAL PACIFIC
HALIBUT COMMISSION



WHAT IS MSE?

Management Strategy Evaluation (MSE) is a process to evaluate the consequences of alternative management procedures. MSE uses a simulation tool to determine how alternative management procedures perform given a set of pre-defined fishery and conservation objectives, taking into account the uncertainties in the system. Processes that cannot be controlled, such as environmental effects, can be included as a source of variability, or by simulating specific scenarios to understand how different levels of the process affect the outcomes.

Undertaking an MSE requires scientists, managers, and stakeholders to be involved throughout the process. While the scientists do the modelling, managers must offer extensive input. Because of the many steps and the iterative process, communication among parties is critical for achieving buy-in on the results of the management strategy evaluation. The MSE is an essential part of the process of developing and agreeing to a harvest strategy policy.

AN MSE FOR PACIFIC HALIBUT

An operating model for Pacific halibut simulates the population dynamics within and between four regions across the Northeast Pacific Ocean. Fishing, movement, reproduction, and growth are modelled and simulated forward in time assuming a consistent harvest strategy. Variability in age-0 recruitment and growth are included. Outputs aggregated across all four regions (coastwide) include the future expected stock size, the expected fishery mortality limits (i.e. TCEY), and the interannual variability in the fishery mortality limits. These outputs are also available at the regional level. The IPHC Management Strategy Advisory Board (MSAB) provides input into the MSE process and the Commission uses the results in the development of a Harvest Strategy Policy.

THE MSE PROCESS

DEFINE FISHERY & CONSERVATION OBJECTIVES

IDENTIFY MANAGEMENT PROCEDURES (MPs) TO EVALUATE

SIMULATE THE PACIFIC HALIBUT POPULATION USING THOSE MPs

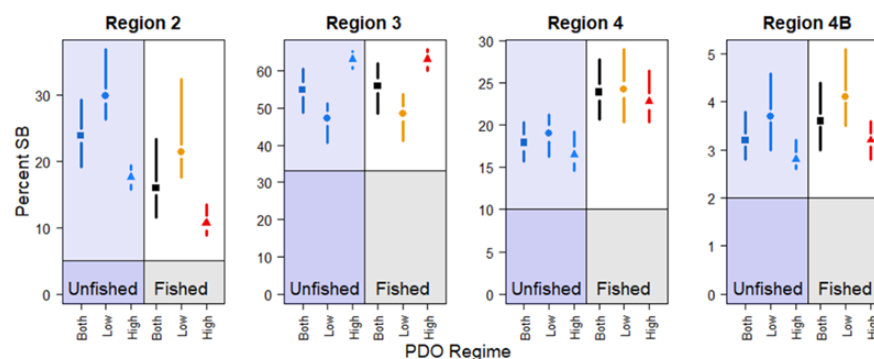
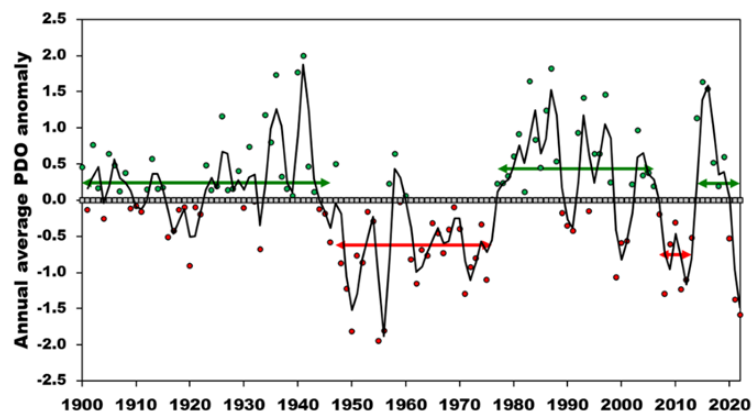
EVALUATE RESULTS TO EXAMINE TRADE-OFFS

IMPLEMENT THE CHOSEN HARVEST STRATEGY WITH THE TESTED MP

MSE SIMULATION ELEMENTS

AN OPERATING MODEL SIMULATES THE PACIFIC HALIBUT POPULATION INTO THE FUTURE

A MANAGEMENT PROCEDURE DETERMINES THE FISHING MORTALITY LIMITS AND FEEDS BACK INTO THE OPERATING MODEL



THE EFFECTS OF THE ENVIRONMENT ON PACIFIC HALIBUT

A strong correlation between the environmental conditions in the northeast Pacific Ocean, specifically the Pacific Decadal Oscillation (PDO), and recruitment of Pacific halibut to the commercial fishery during the 1900s has been identified. For Pacific halibut, the positive 'phase' of the PDO (years up to and including 1947, 1977-2006, and 2014-19) appears to have resulted in typically higher average recruitment. Additional work suggests that movement and the distribution of age-0 Pacific halibut are also different depending on the phase of the PDO.

Since the late 1800's the PDO has oscillated between warm and cold phases at least 4 times. Recent research, however, shows many other environmental indicators were highly anomalous in recent years, and it is unclear whether these years represent comparable conditions to previous PDO observations.

A CHANGING ENVIRONMENT AND THE MANAGEMENT OF PACIFIC HALIBUT

The Pacific halibut population was simulated forward in time, with fishing mortality similar to what has occurred recently, assuming that the PDO was either always low or always high. The environment has a modest effect on the coastwide fishing mortality limits with the expected TCEY being 1.6 times greater in a high PDO regime when compared to a low PDO regime, although the interannual variability is the same. This is because the population size is smaller, thus fewer fish can be harvested in a persistent low PDO regime. Fishing and the environment affect the proportion of spawning biomass in each Biological Region in different ways. Region 2 (CA, OR, WA, BC, and SE AK) is affected by both the PDO and fishing. Region 3 (central Gulf of Alaska) is mostly affected by the PDO regime and fishing has little effect on the proportion of spawning biomass because fish move into this region at different rates depending on the PDO regime. Region 4 (western Gulf of Alaska and the Bering Sea) is mainly affected by fishing as fish generally move out of this region. Region 4B (Aleutian Islands) is affected by both fishing and the PDO regime because few fish move in or out of this region, but recruitment of Pacific halibut is dependent on the PDO regime.

INFLUENCES OF THE PDO ON PACIFIC HALIBUT

LOW PDO

Low average recruitment
Typically, less recruitment in Region 4
Less movement from Region 4 to 3
More movement from Region 3 to 2

HIGH PDO

High average recruitment
Typically, more recruitment in Region 4
More movement from Region 4 to 3
Less movement from Region 3 to 2

RESULTS OF THE SIMULATIONS

THE COASTWIDE TCEY IS 1.6 TIMES GREATER, ON AVERAGE, WITH A PERSISTENT HIGH PDO

AREAS ARE AFFECTED DIFFERENTLY BY FISHING AND BY THE ENVIRONMENT

Long-Term Performance Metrics			
PDO	Both	Low	High
Median RSB	38.8%	37.6%	39.2%
P(RSB<20%)	<0.001	<0.001	<0.001
P(RSB<36%)	0.238	0.329	0.157
Median TCEY (Mlbs)	65.6	51.4	83.0
Median AAV of TCEY	5.2%	4.5%	4.5%
Median TCEY Region 2 (Mlbs)	20.5	19.1	21.2
Median TCEY Region 3 (Mlbs)	33.7	23.0	48.7
Median TCEY Region 4 (Mlbs)	8.1	6.6	9.4
Median TCEY Region 4B (Mlbs)	2.4	2.2	2.6

FOR MORE INFORMATION



<https://www.iphc.int/research/management-strategy-evaluation/>

IMPORTANCE TO DECISION MAKING

Even though we cannot “manage” the PDO regime, it is useful to understand the effects of the PDO regime on the Pacific halibut population and fisheries, separating the effect of fishing from the effects of the environment. In some cases, the environment may have a bigger effect on yield and the distribution of spawning biomass than fishing at a specific rate does. The environment is certainly influential on management outcomes and investigating the effects of a single regime on the management of Pacific halibut helps to understand the variability and uncertainty in the potential management outcomes.

In reality though, the environment is variable and often unpredictable. Therefore, the MSE simulations informing Commissioners, and the development of a Harvest Strategy Policy, oscillate randomly between PDO regimes and integrate the uncertainty of the environmental regime into the results. Including this variability provides the assurance that a chosen harvest strategy meets management objectives and is robust to uncertainty in the environment.

REFERENCES

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EFFECTS OF THE ENVIRONMENT AND FISHING

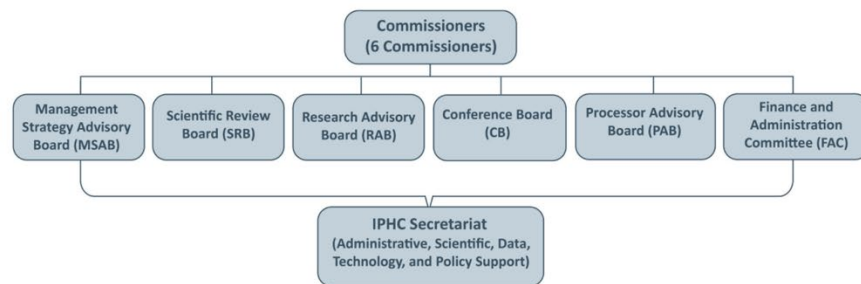
THE ENVIRONMENT IS VARIABLE AND OFTEN UNPREDICTABLE
 THE ENVIRONMENT SCALES THE PRODUCTIVITY OF THE STOCK AND
 CHANGES THE DISTRIBUTION AMONG BIOLOGICAL REGIONS
 UNDERSTANDING THE EFFECTS OF THE ENVIRONMENT IS USEFUL,
 BUT THE GOAL IS TO FIND A MANAGEMENT PROCEDURE THAT IS
 ROBUST TO THE VARIABILITY IN THE ENVIRONMENT

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STRUCTURE OF THE COMMISSION



THE COMMISSION

The IPHC currently consists of six members, three appointed by each Contracting Party (the Governor General of Canada and the President of the United States of America), who serve their terms at the pleasure of the Contracting Party.

CANADA



Mark Waddell



Neil Davis



Peter DeGreef

UNITED STATES OF AMERICA



Jon Kurland



Richard Yamada



Robert Alverson

