FACTORING UNCERTAINTY INTO MANAGEMENT ADVICE

HAVE FISHERIES SCIENTISTS GOT THEIR ACT TOGETHER?

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WHAT'S WANTED FROM A KEYNOTE SPEAKER?

Something interesting, informative, entertaining, controversial

SO WHAT DO ORGANISERS DO?

Invite Ray Hilborn

Sorry folks, you've got me because he wasn't available

Apologies again – I won't be mentioning MPAs or updating Ray's "orangutan conversion factor"

> Number of orangutans lost to deforestation to clear more land to grow more crops to replace the sustainable fish harvest lost per unit area of MPA creation

Nevertheless if you don't disagree with at least something I'm going to say

then shame on you as you must be about to fall asleep

OUTLINE

I. Best-assessment-based management and its difficulties

II. Management Procedures (MSE) and feedback

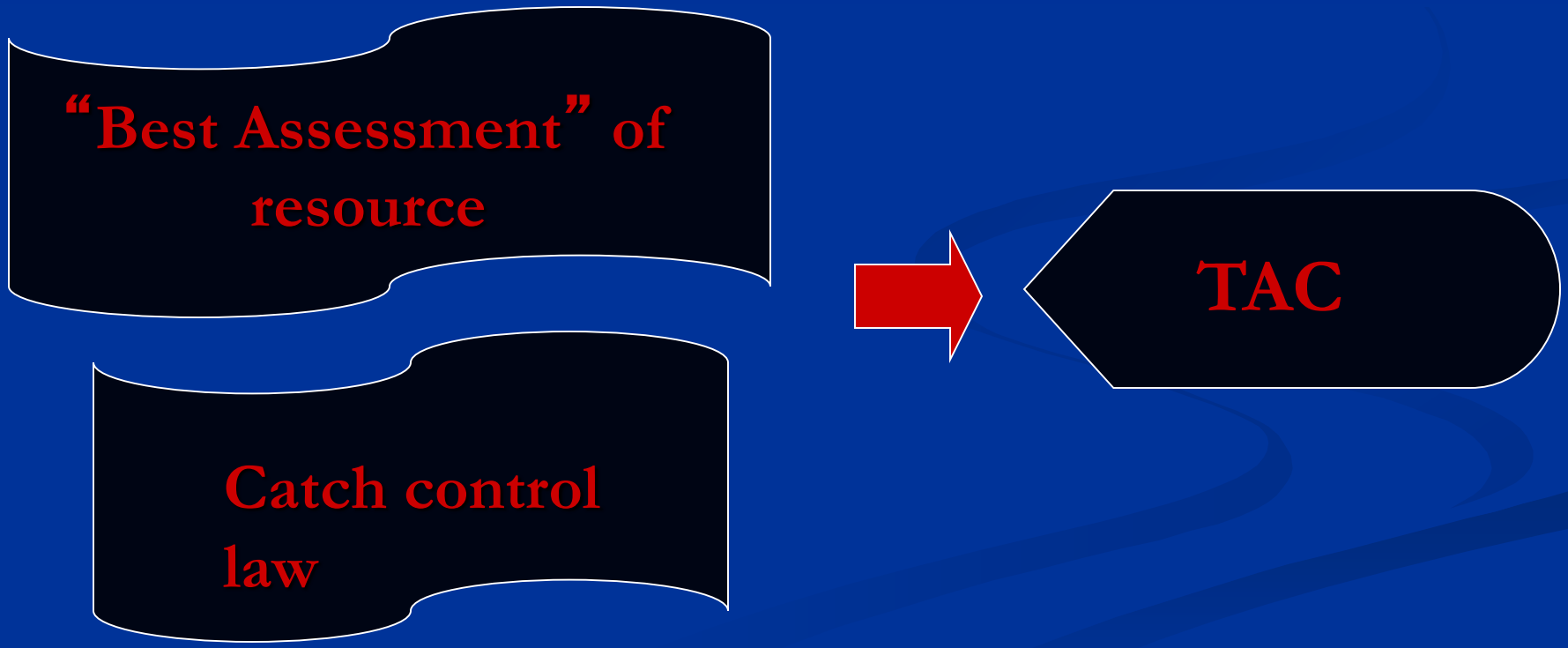
III. How precautionary? – consistency problems

IV. Scientists – key problems and appropriate role

V. Looking ahead

I. BEST-ASSESSMENT-BASED MANAGEMENT

E.g. US Magnuson-Stevens Act with its MSY-related recovery targets



DIFFICULTIES FOR THE BEST-ASSESSMENT-BASED APPROACH

- Inter-annual best assessment/TAC variation (including MSY-related Reference points)
- No consideration of longer term trade-offs (which requires taking account of management responses to future resource monitoring data)
- Lengthy haggling
- What if the "best assessment" is wrong?
- Default decision of "no change"

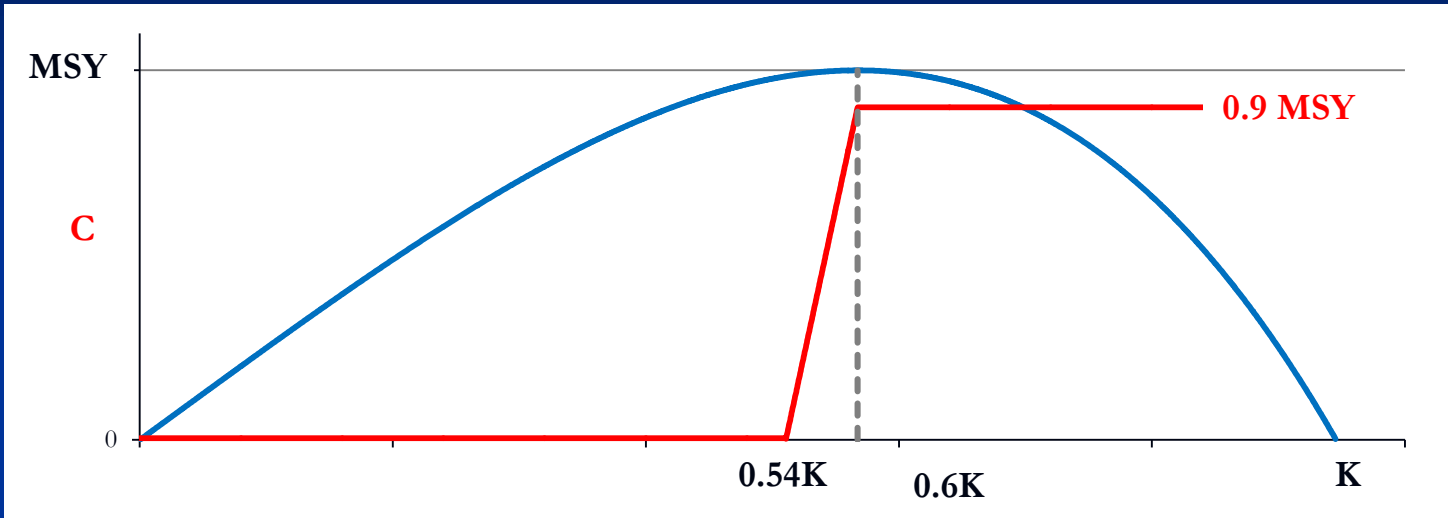
USA FISHERIES

- Number stocks in management plans: about 450
- Model-assessed: about 55%
- Direct F_{msy} estimates: about 40% of those …assessed, or about 22% of the total
- Most common proxy for F_{msy} : F_{spr}%

  40%/22% perhaps on the high side, though some estimates of F_{msy} are not that reliable

MSY-related targets generally not well determined

IWC NEW MANAGEMENT PROCEDURE (NMP) 1976



Harvest Control Rule:

C = 0 for P < 0.54 K

C = 0.9 MSY for P > 0.60 K

Input required to calculate C:

P: current abundance

K: pristine abundance

MSY

1980s: FAILURE OF THE NMP

- How to calculate P, K and MSY?
- How to take uncertainties into account?

Walter Zucchini

"Don't parametrise the world if you can't estimate the parameters"

Must be able to operationalise any management approach

IWC SOLUTION:

Move to a "management procedure approach"

KEY DIFFICULTIES FOR IWC NMP

- Inter-annual best assessment/TAC variation (including MSY-related Reference points)
- What if the "best assessment" is wrong?

DITTO US MAGNUSON-STEVENS ACT

Why has the IWC lesson still not been learnt three decades later?

BUT WHY IS FISHERIES MANAGEMENT SO DIFFICULT?

SUSTAINABLE UTILISATION

- Pensioner must live off interest
- What's my capital?
- What's the interest rate?
- Multiply the two
- Don't spend more than that!

EASY!!

THE SOURCE OF THE DIFFICULTY

FISHERIES HAVE UNCO-OPERATIVE BANK TELLERS

- They won't tell you the interest rate, which in any case is highly variable

  Recruitment fluctuations

- They will advise your balance only once a year, with a typically +-50% error, and in the wrong currency

  Surveys are typically annual only, results have high variance, and bias unknown

II. MANAGEMENT PROCEDURES (MSE)

WHAT NEW DO THEY BRING TO ASSIST SOLVE THE PROBLEM?

FEEDBACK CONTROL!

Monitor stock changes and adjust management measures (e.g. TACs) accordingly

A FINANCIAL ANALOGY

$1 000 000 invested at 5% p.a.

Each year withdraw $50 000 ⇒

Investment sustainably maintained at $1 000 000

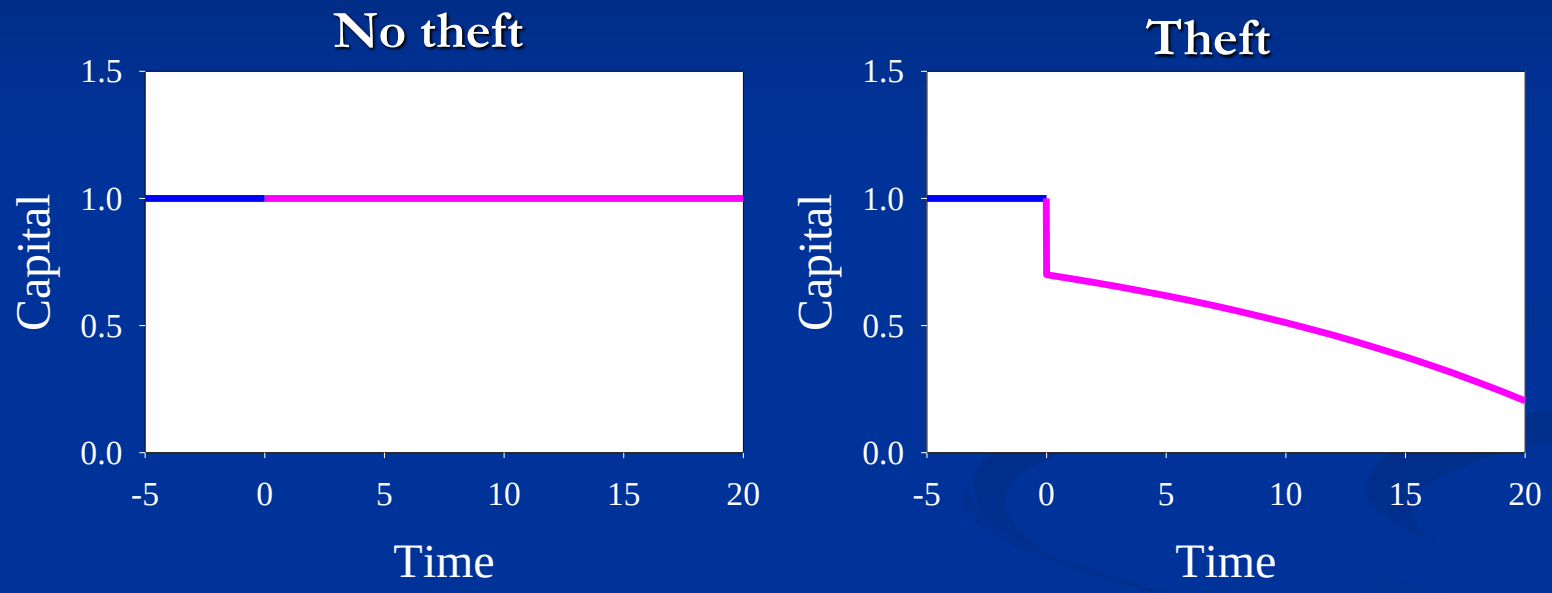
1 000 000 ton fish stock grows naturally at 5% p.a.

Each year catch 50 000 tons ⇒

Sustainable exploitation: resource kept at 1 000 000 tons

After 5 years, someone MAY have stolen $300 000 from your investment

You keep withdrawing $50 000 per year



After 5 years, recruitment failure or IUU fishing MAY have reduced abundance by 30%

Catches maintained at 50 000 tons per year

If this event did occur, resource is rapidly reduced

WHY'S THERE ANY PROBLEM?

Ask the teller for account balance.
If this has fallen to $700 000, reduce annual withdrawal to $35 000 ⇒
Sustainability maintained.

BUT

The teller will advise balance only once a year with ±50% error

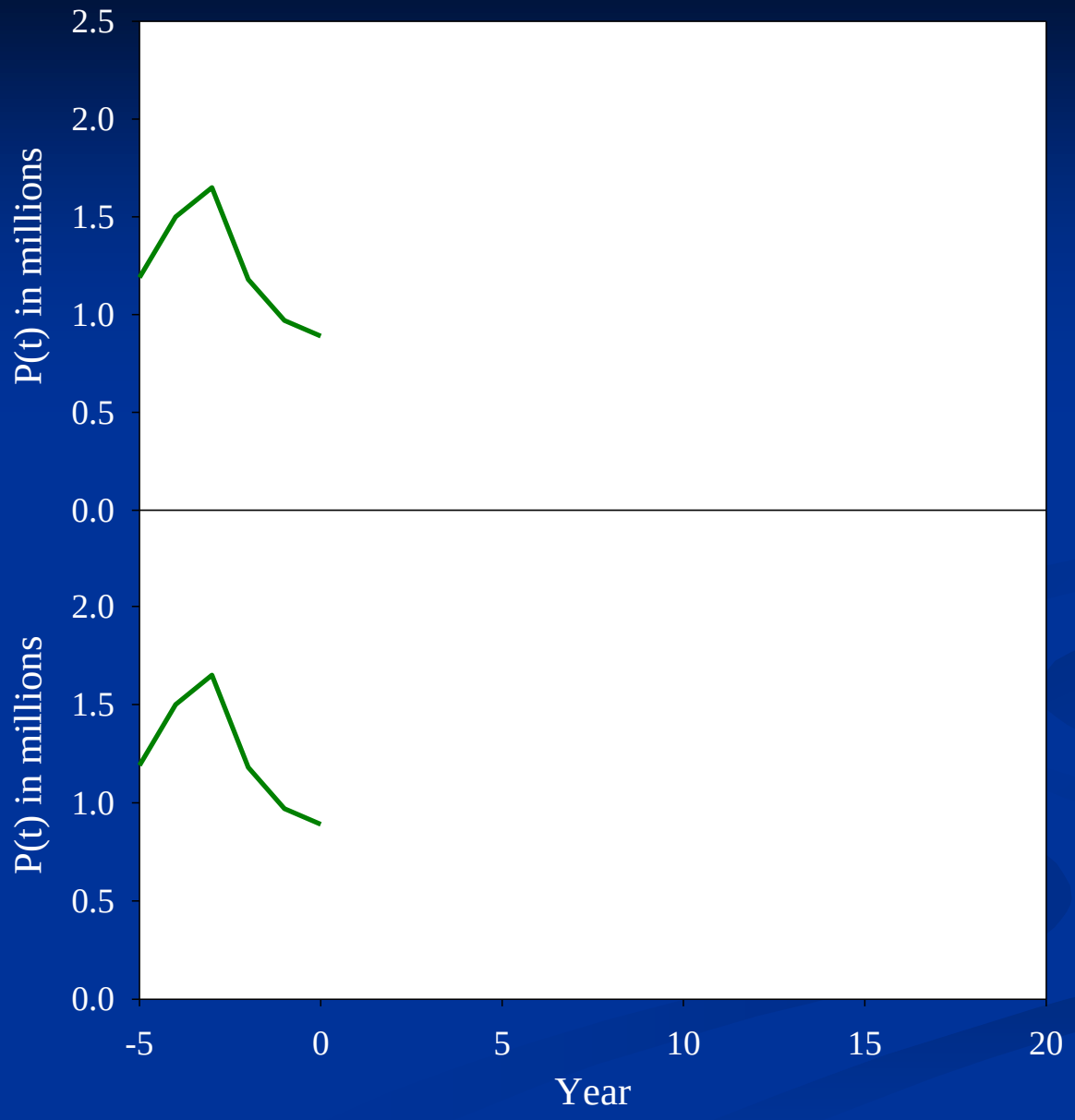
Resource abundance known only through annual surveys which have large associated errors

CAN YOU TELL WHETHER $300 000 WAS STOLEN FROM YOUR ACCOUNT ?

(Equivalently, whether fish abundance was reduced by 30%?)

In each of the following scenarios shown, the theft occurred in only one of the two cases

Can you tell which one?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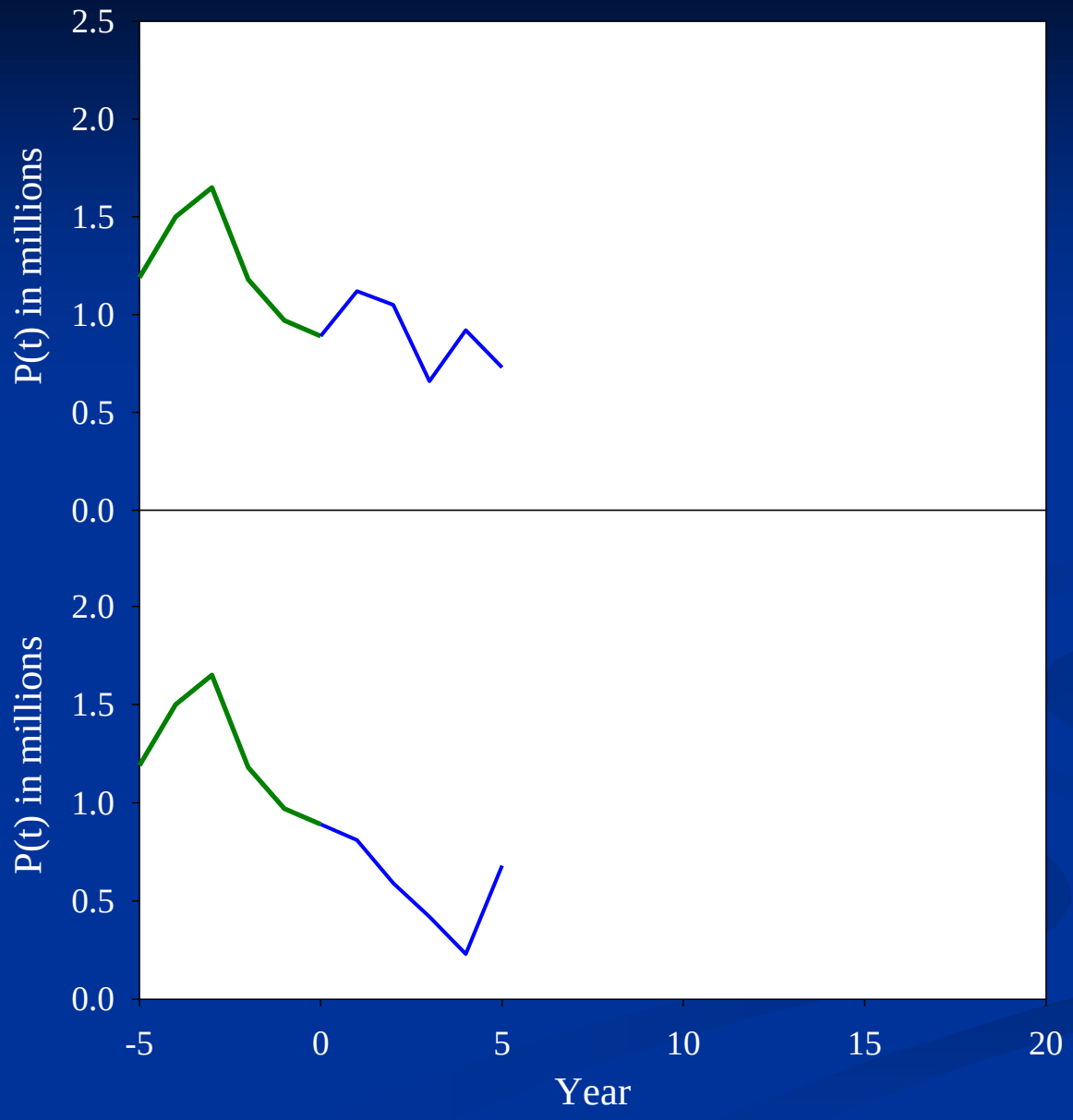
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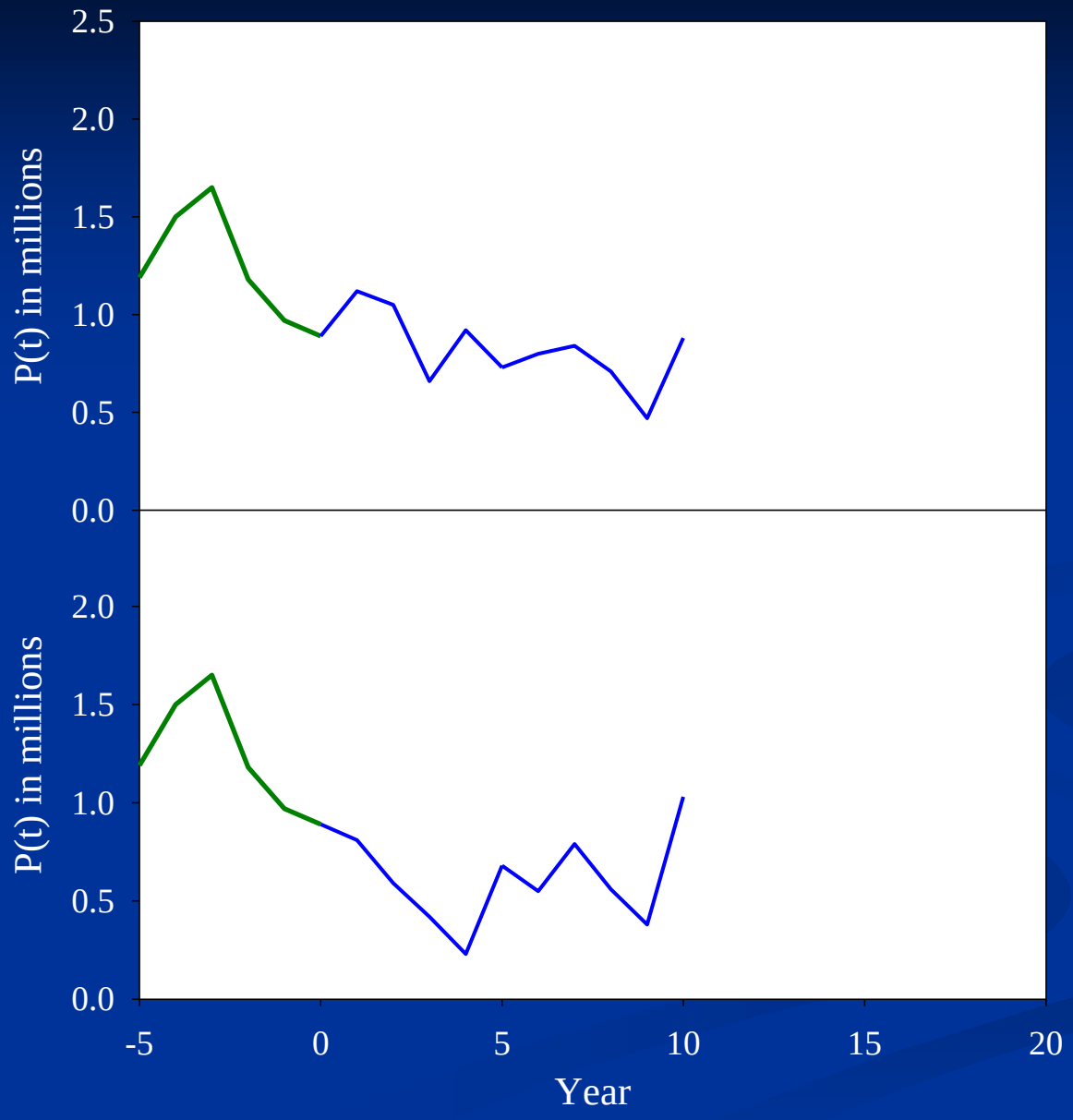
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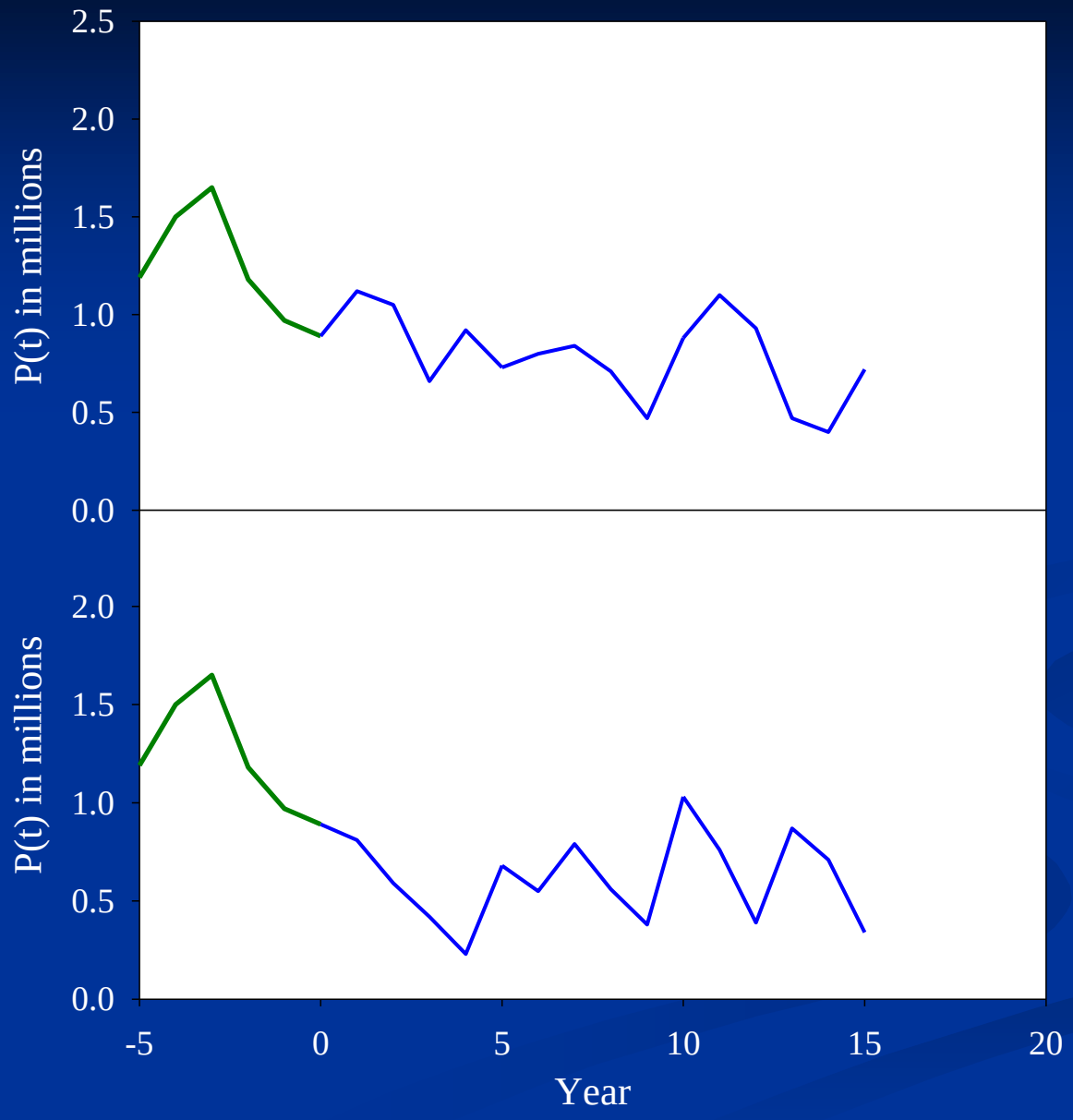
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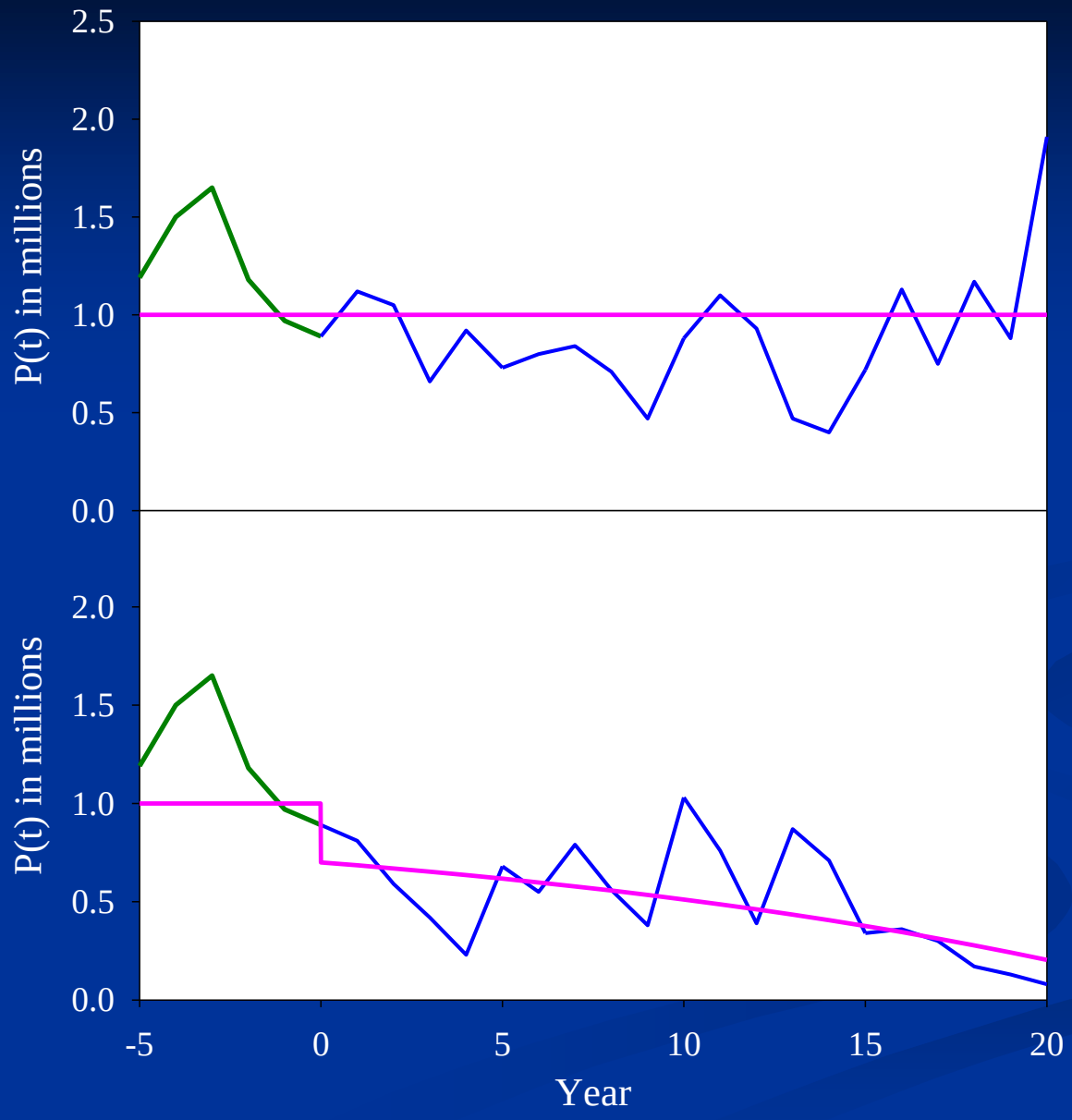
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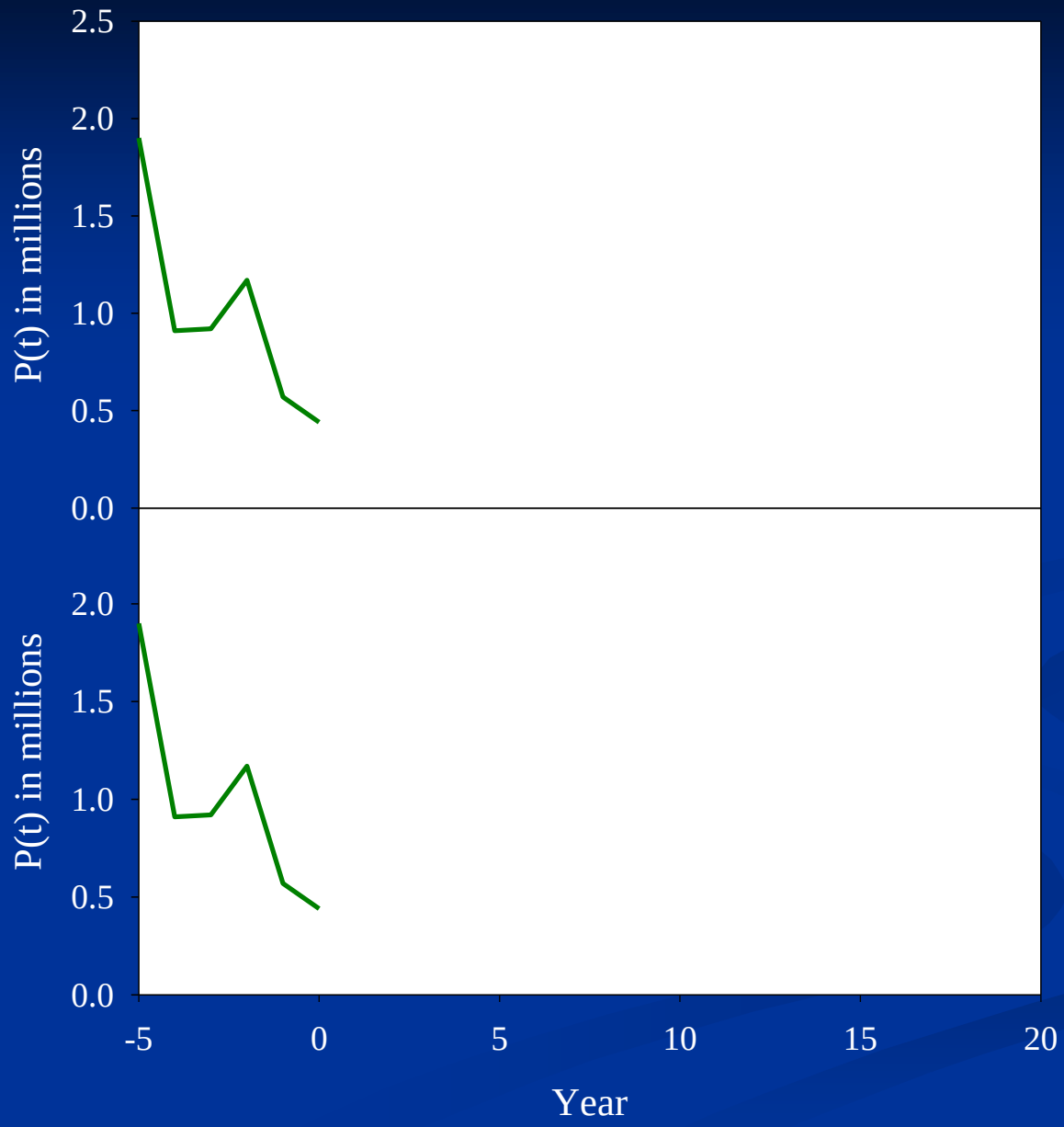
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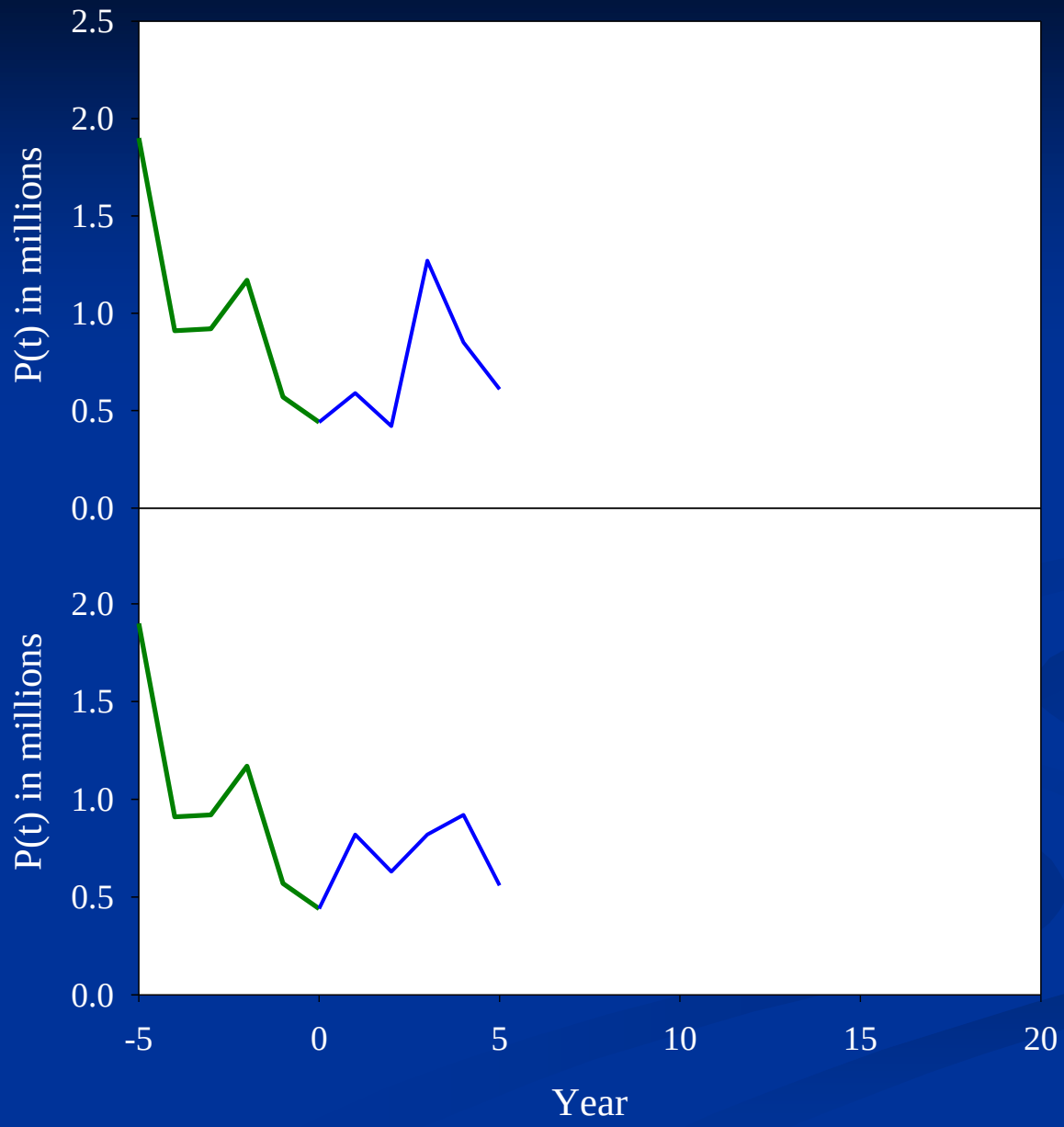
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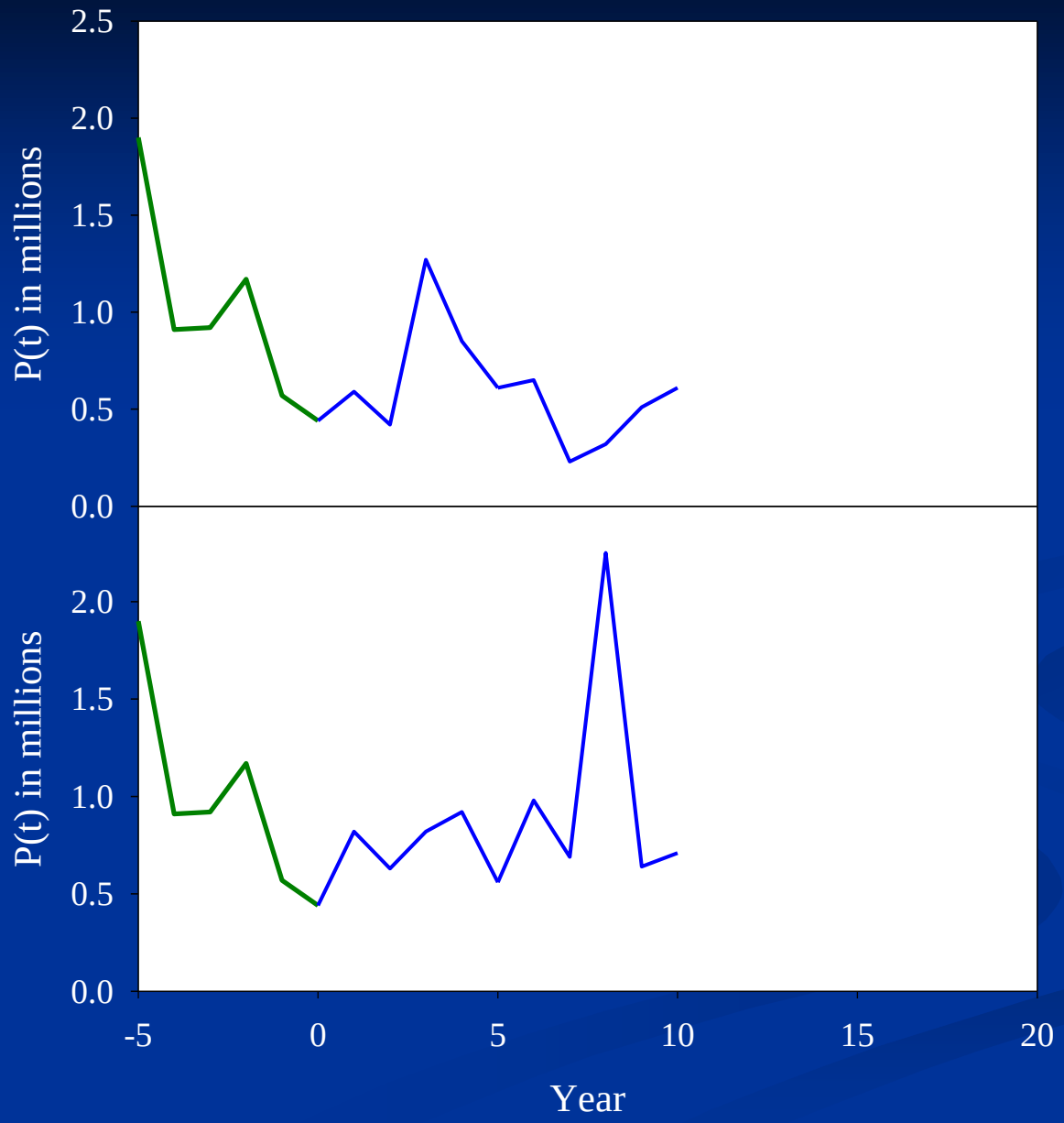
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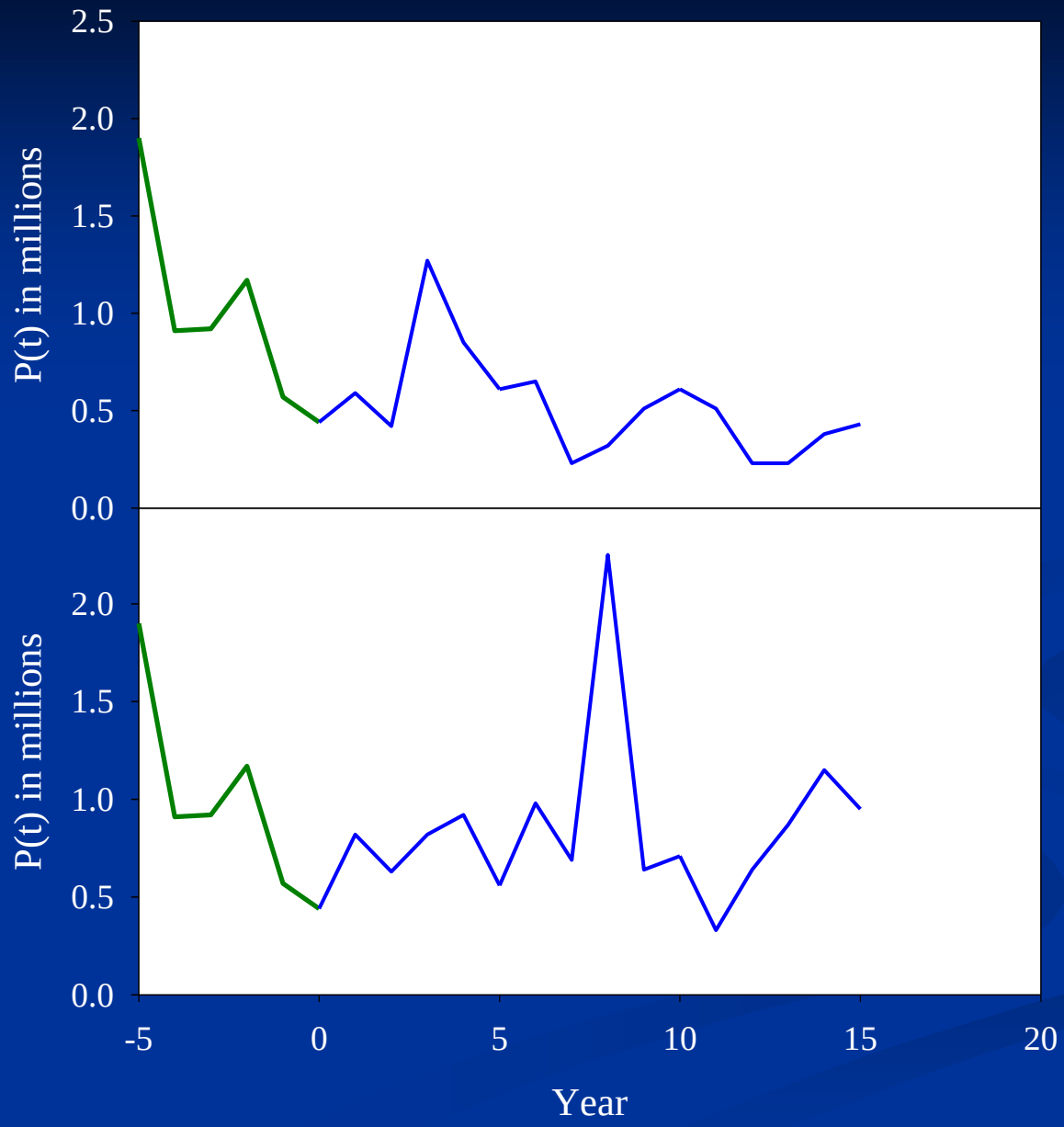
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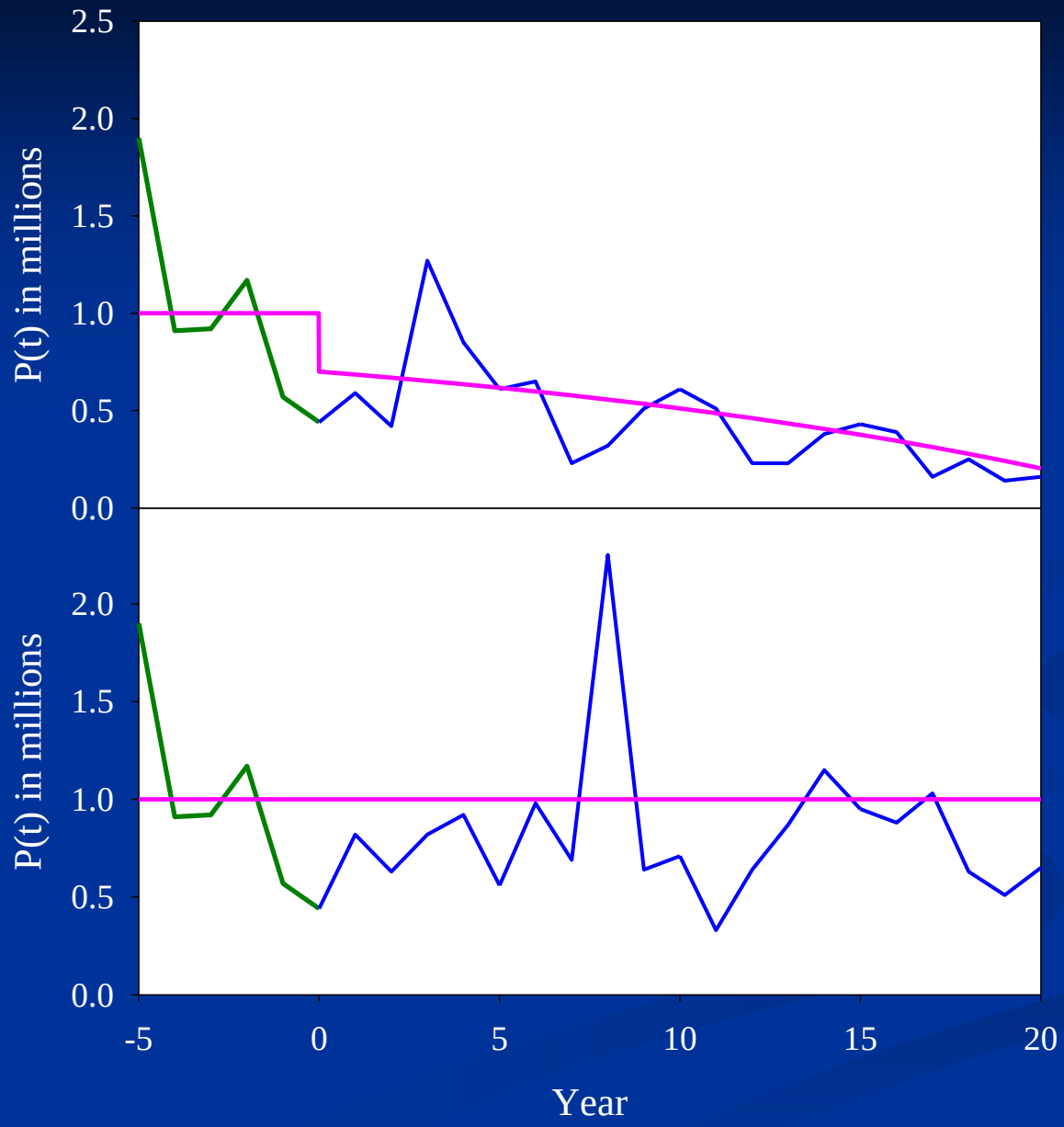
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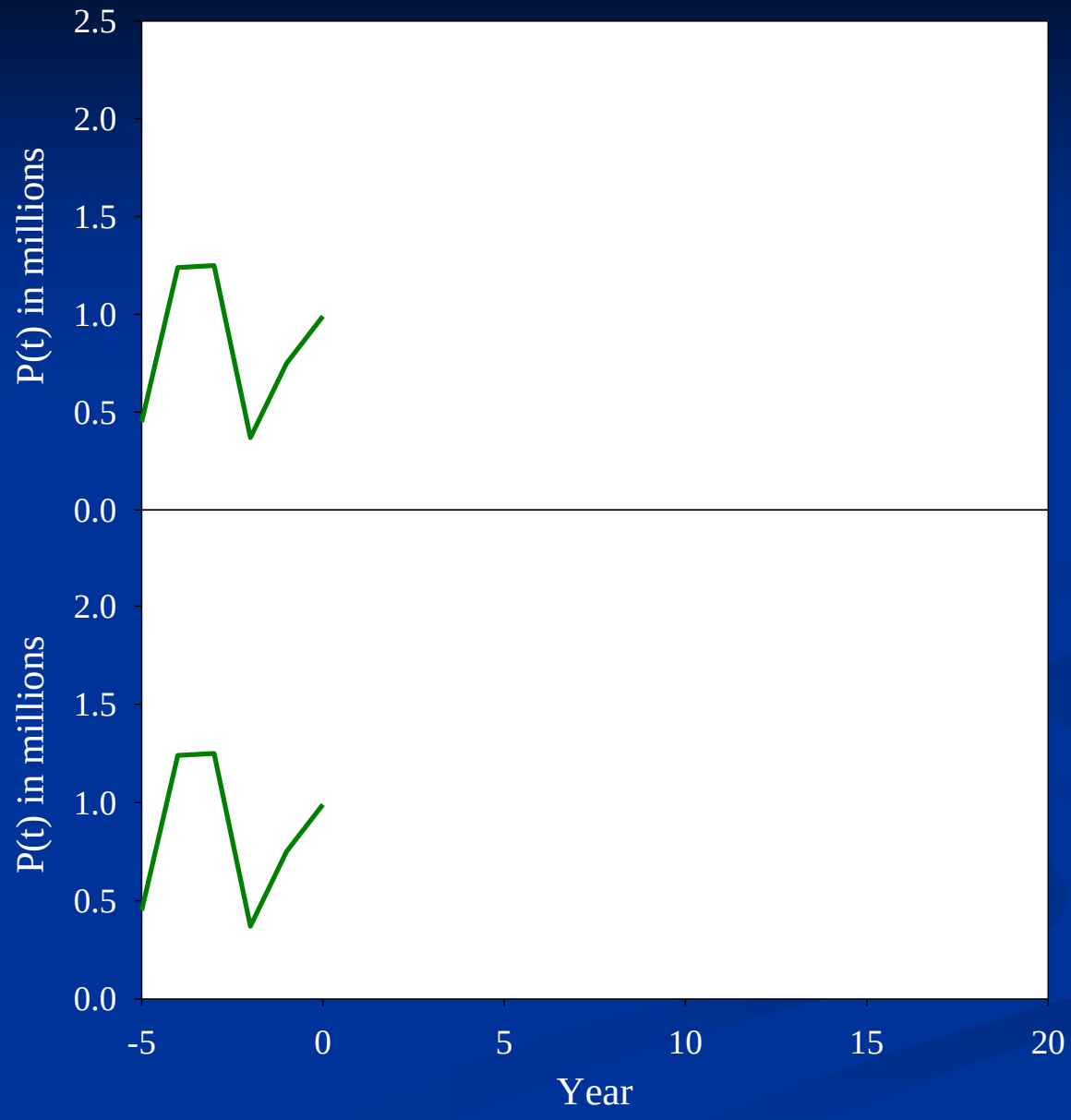
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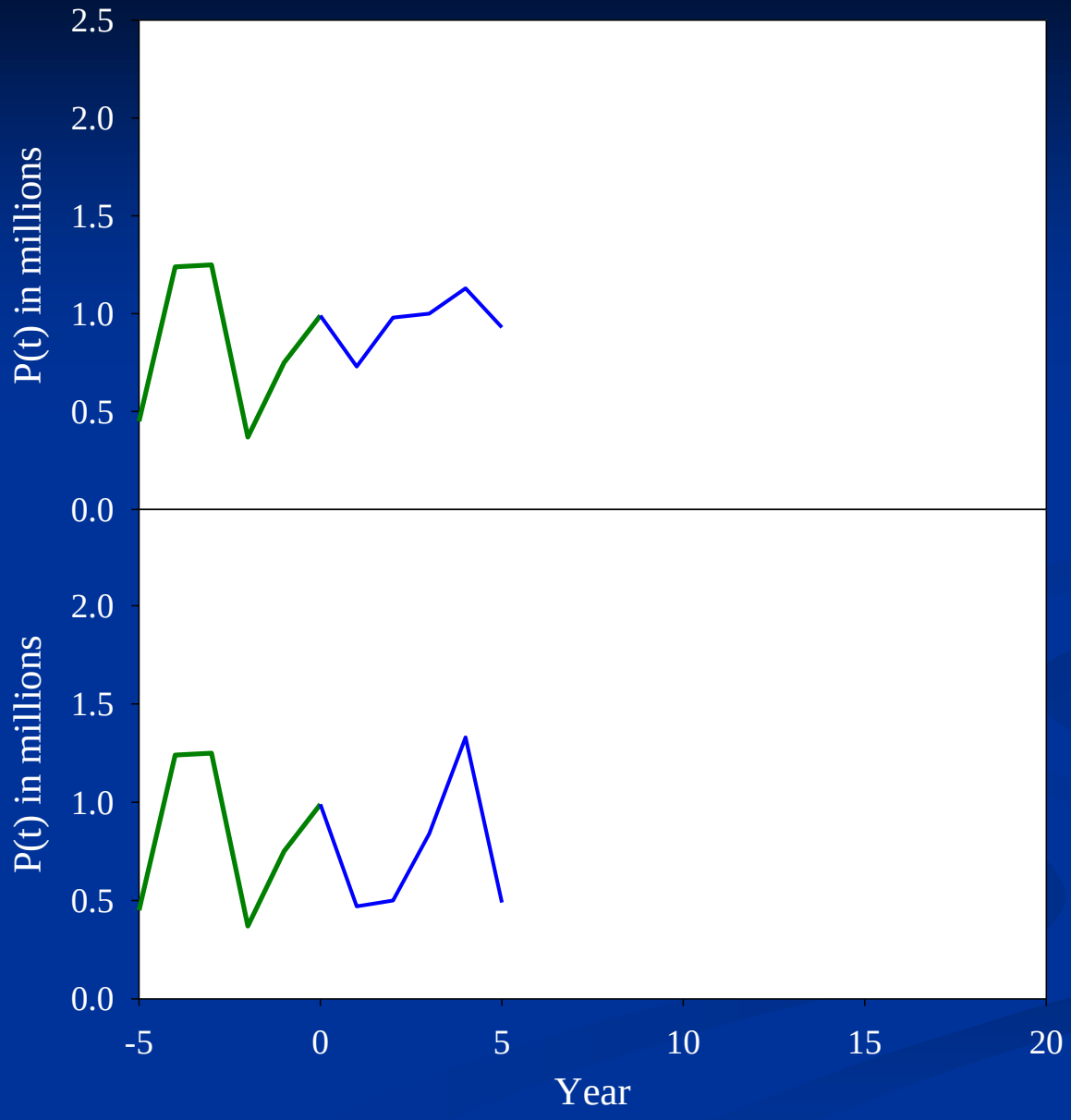
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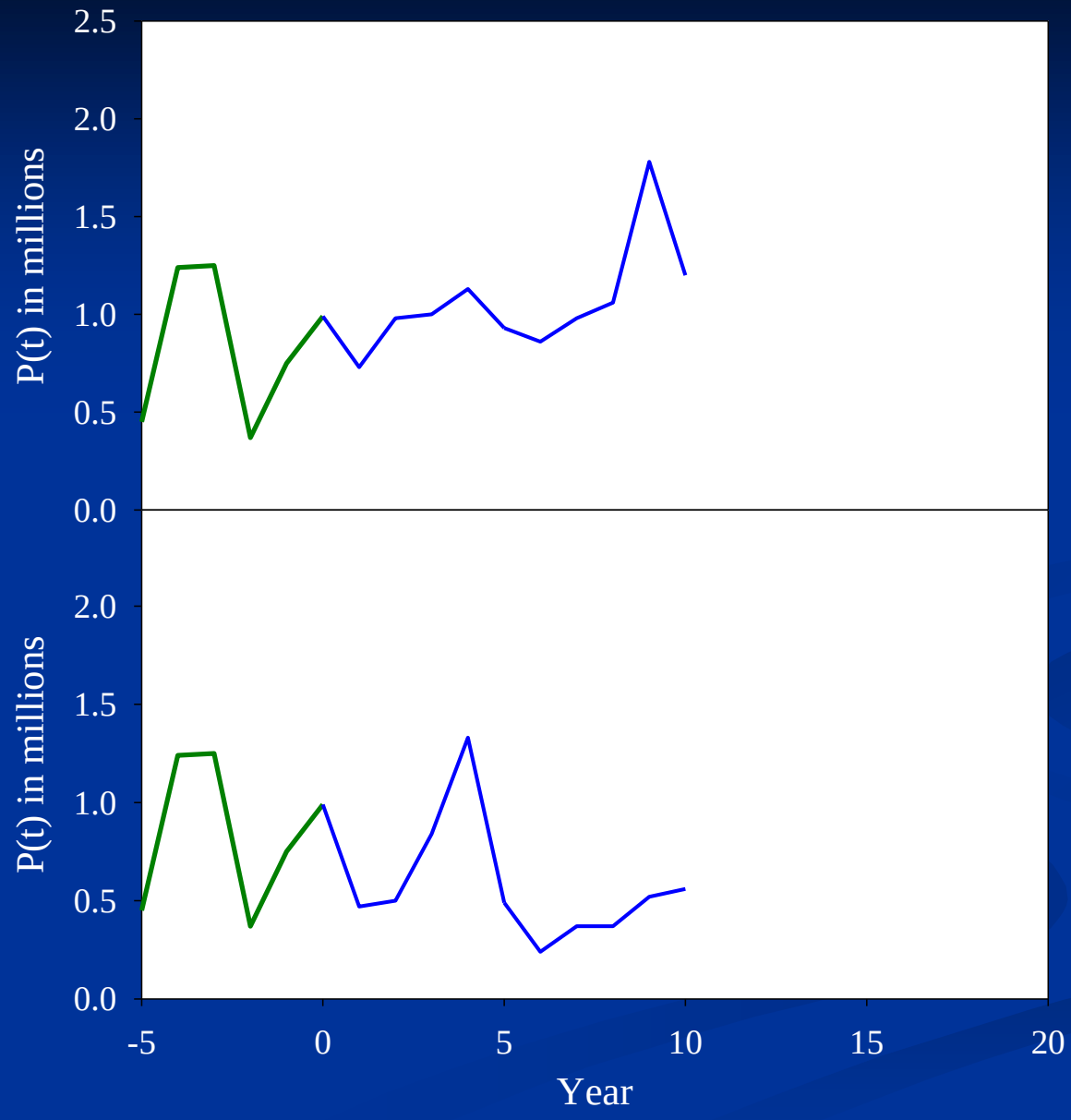
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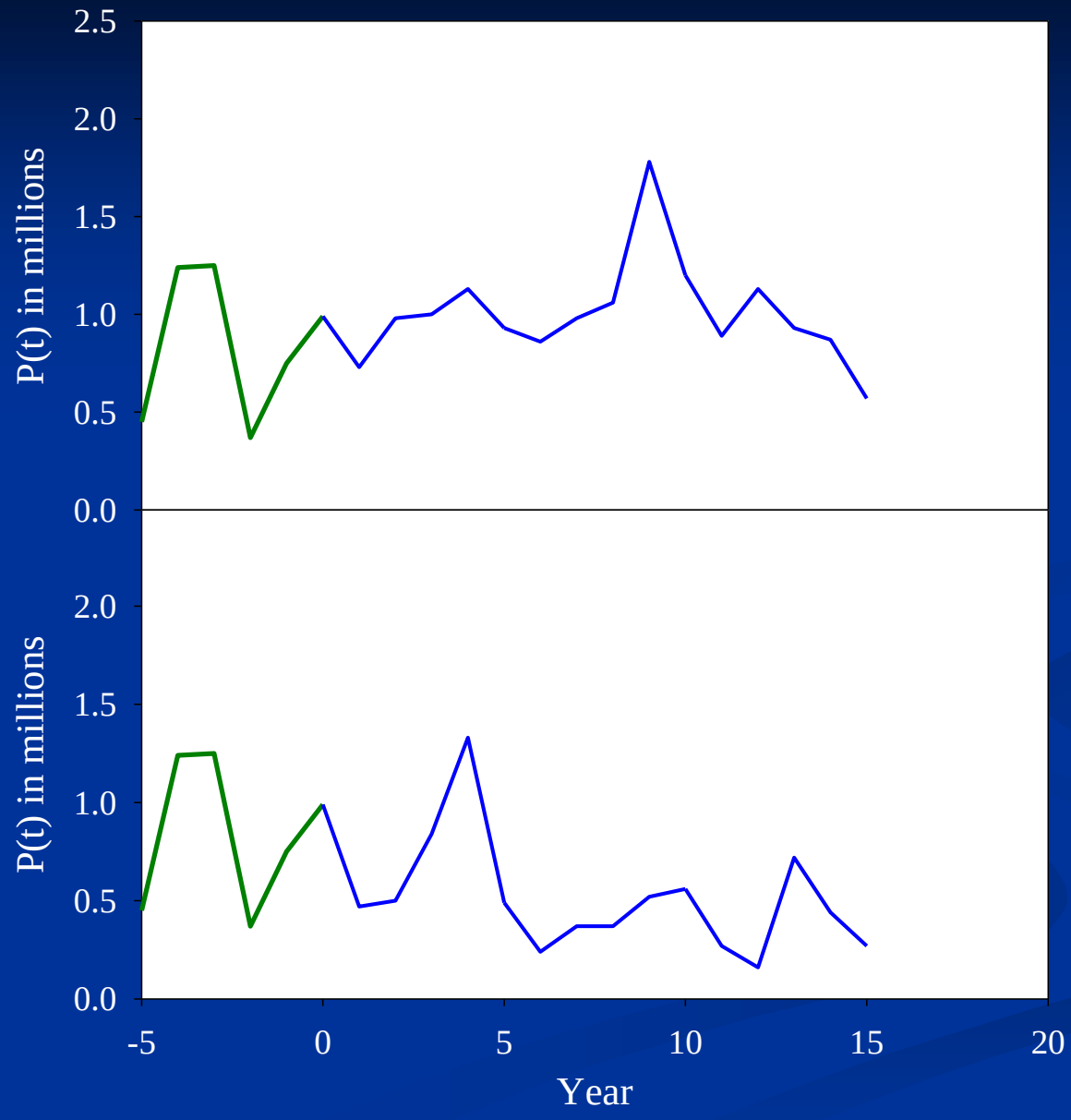
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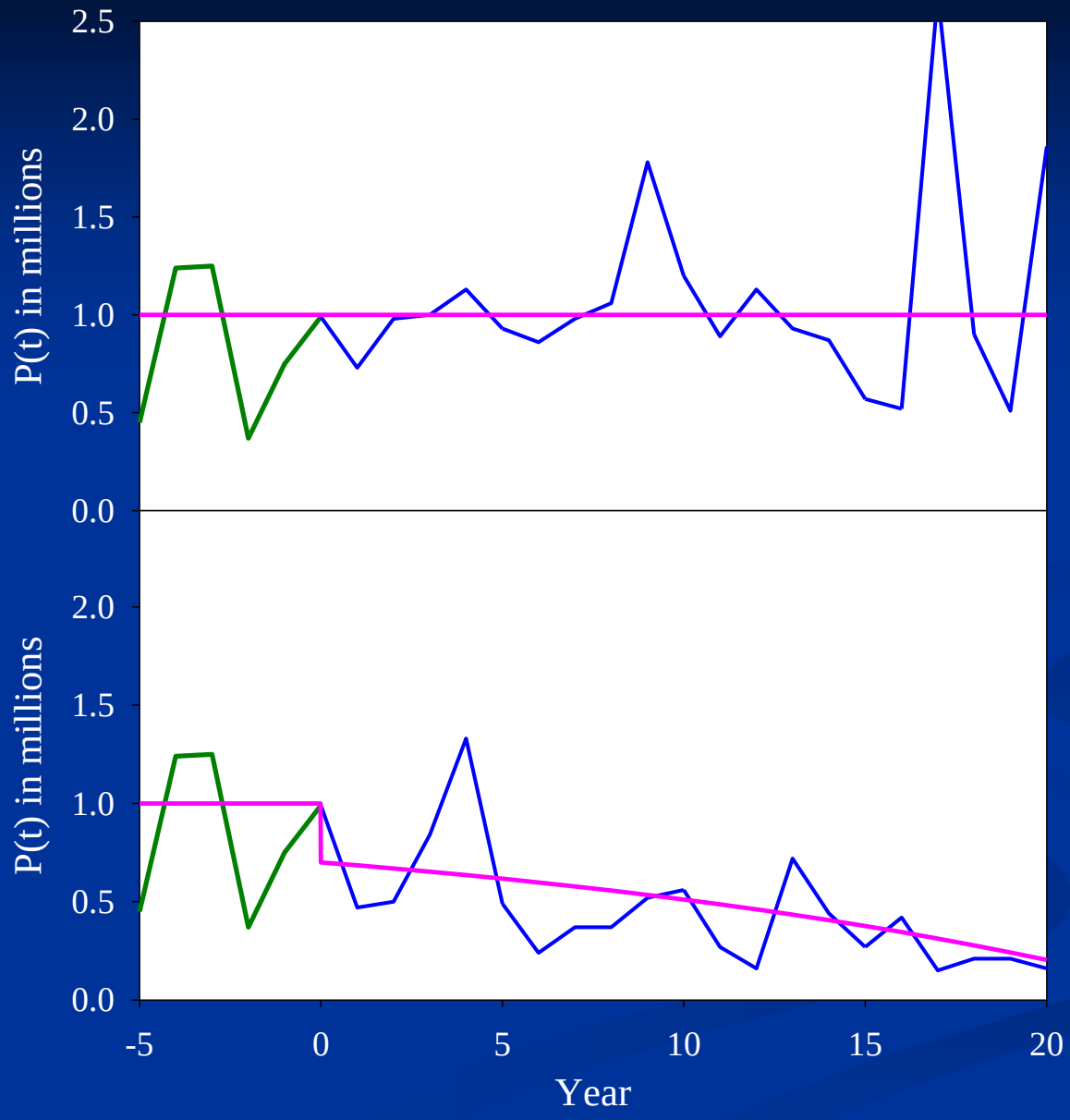
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IMPRESSIONS

- It wasn't easy to tell
- It needed usually about 20 years of new data to be certain
- By that time, account was almost exhausted (if theft had occurred)
- By the time the adverse effect of recruitment failure or IUU fishing is detectable, the resource is already heavily depleted

THREE STRATEGIES (MPs)

I: Withdraw $ 50 000 every year

II: Withdraw 5% of the teller-advised balance each year

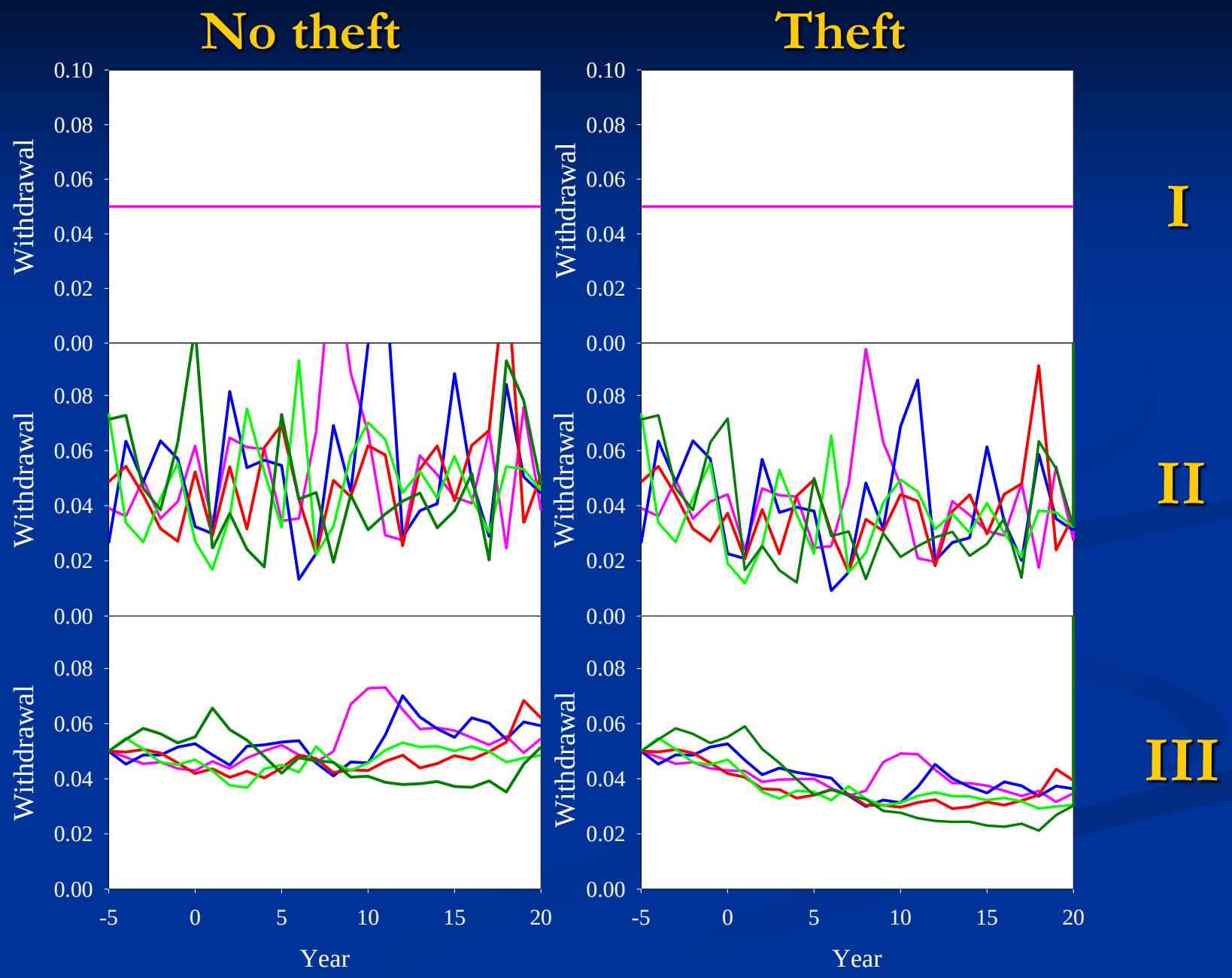
III: Withdrawal this year = 80% last year's withdrawal + 1% teller balance

Strategy must "work" whether or not theft occurred

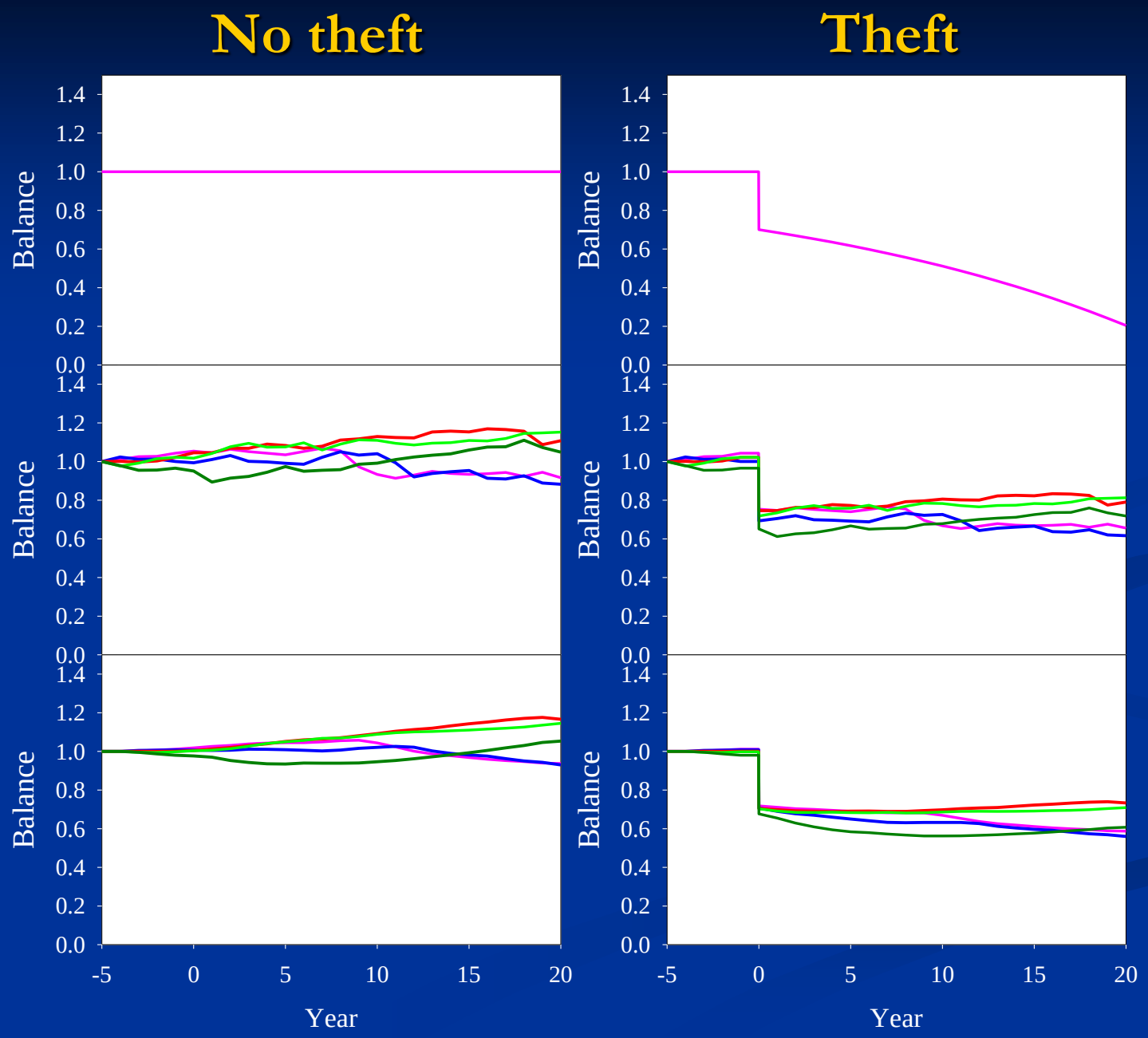
Annual Withdrawal

Balance in Account

Annual Withdrawal



Balance in Account



PERFORMANCE

I: Going bankrupt if theft occurred

II: Stabilises balance in account, but annual withdrawals too variable

III: Best of the three – stabilises balance without too much change from year to year

Formula III automatically corrects for effect of recruitment failure/IUU fishing if it occurred.

"Feedback control" (MP basis)

THE MANAGEMENT PROCEDURE APPROACH (MSE)

1) Specify alternative plausible models of resource and fishery (Operating Models – OMs)
2) Condition OMs on data (effectively alternative assessments); pre-specify future data inputs to MP
3) Agree performance measures to quantify the extent to which objectives are attained
4) Select amongst candidate MPs for the one showing the "best" trade-offs in performance measures across objectives and different OMs in simulation testing

MPs: THE DIFFICULT (Assessment-based-management) MADE EASY?

How well could simple management procedures have performed if applied to some North Atlantic stocks 20 years ago?

Develop MPs based on what was known in 1990, and see how they would have worked

(Helena Geromont)

THE SIMPLE MPs

APPLIED TO ONE ABUNDANCE INDEX

[Constant catch: For comparison**]**

Slope: TAC increased or decreased in proportion to recent abundance index (e.g. survey) trend

Target: TAC increased or decreased in proportion to the extent by which the abundance index exceeds or falls below a target index level

NOTE FEEDBACK NATURE

SIMPLE MPs

Constant catch MP: $TAC_{y+1} = TAC^{target}$

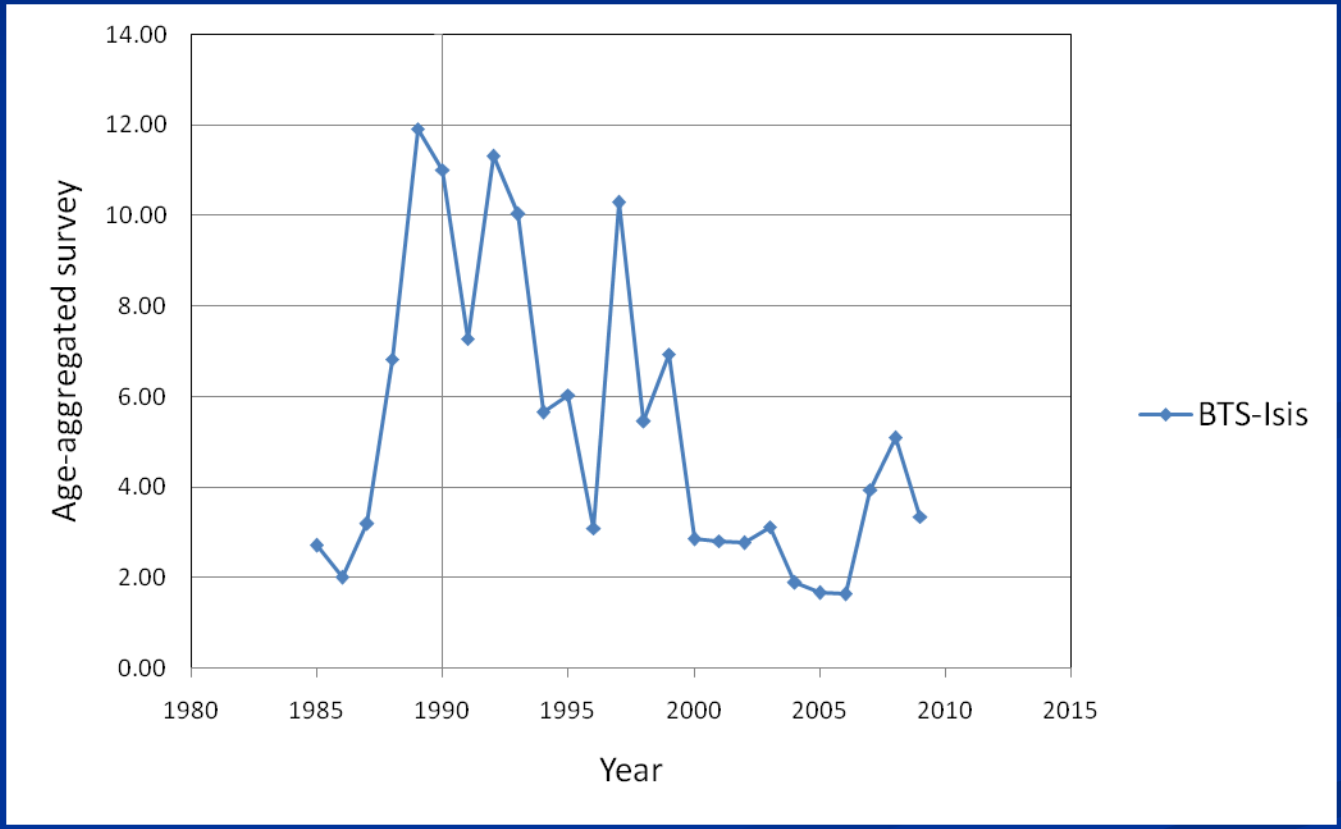
Slope MP: $TAC_{y+1} = TAC_y(1 + \lambda s_y)$

Target MP: $$TAC_{y+1} = TAC^{target}\left[w + (1 - w)\left(\frac{I_y^{recent} - I^0}{I^{target} - I^0}\right)\right]$$

(I = index of abundance available annually)

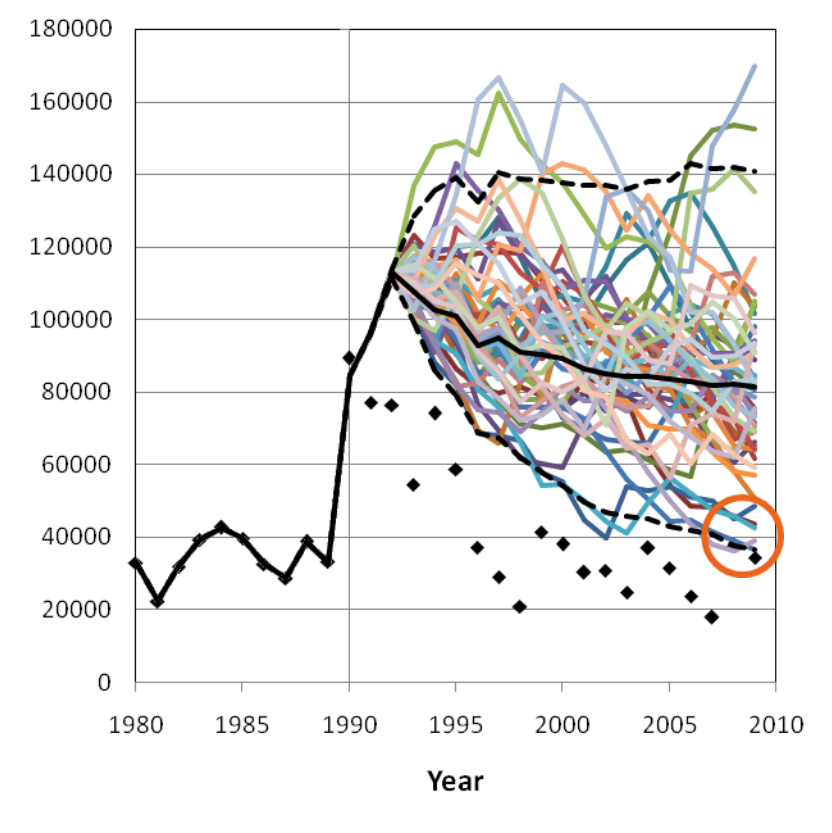
DATA: SURVEY INDEX

North Sea Sole (Subarea IV)

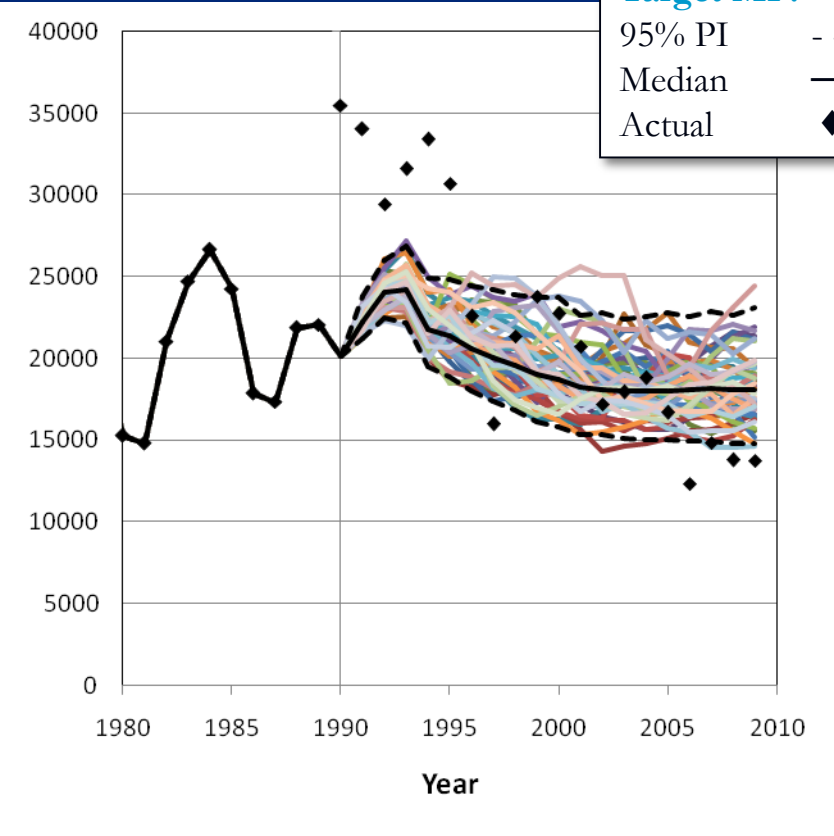


PROJECTIONS UNDER UNCERTAINTY IN 1990

North Sea Sole (Subarea IV)



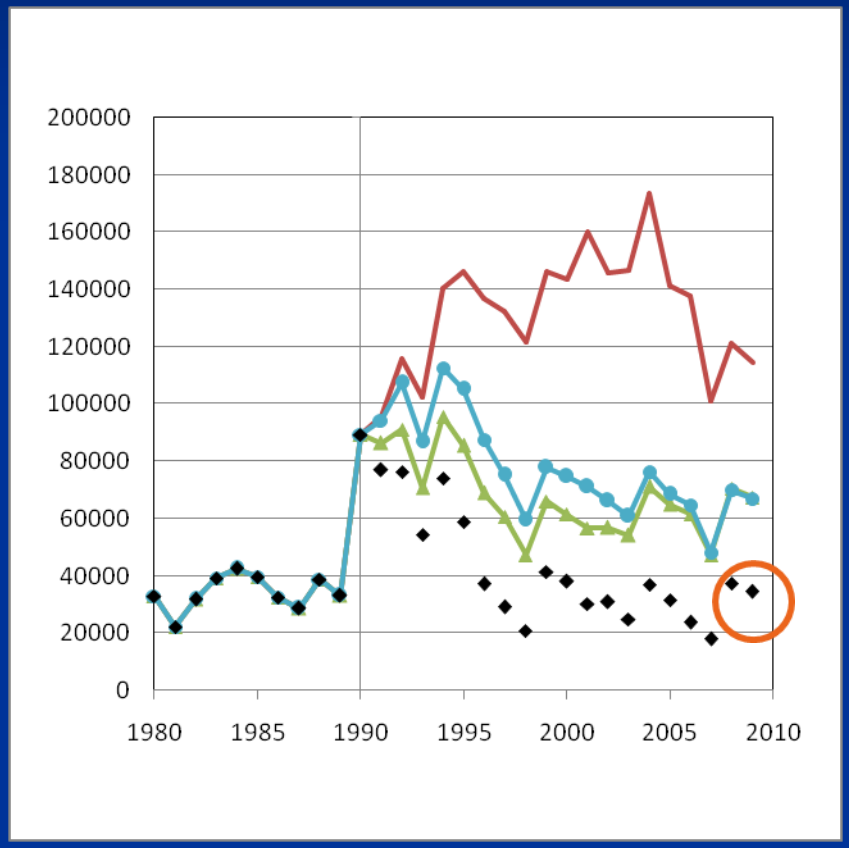
Spawning biomass (tons)



Annual catch (tons)

WHAT WOULD HAVE HAPPENED

North Sea Sole (Subarea IV)



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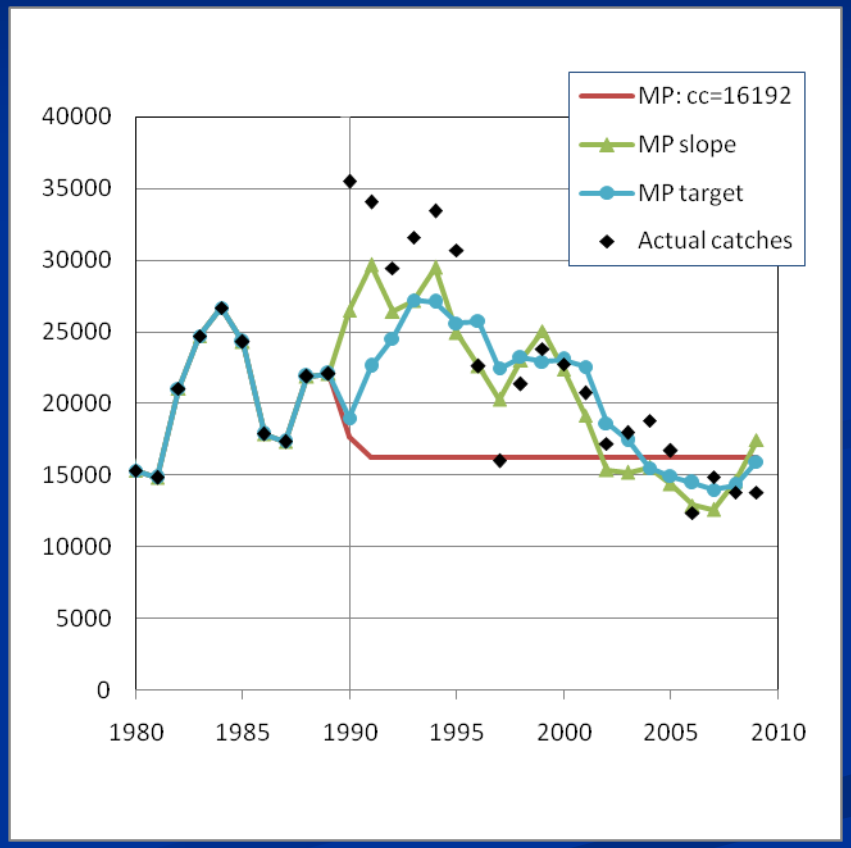

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WHAT WOULD HAVE HAPPENED

COMPARISONS TO WHAT OCCURRED

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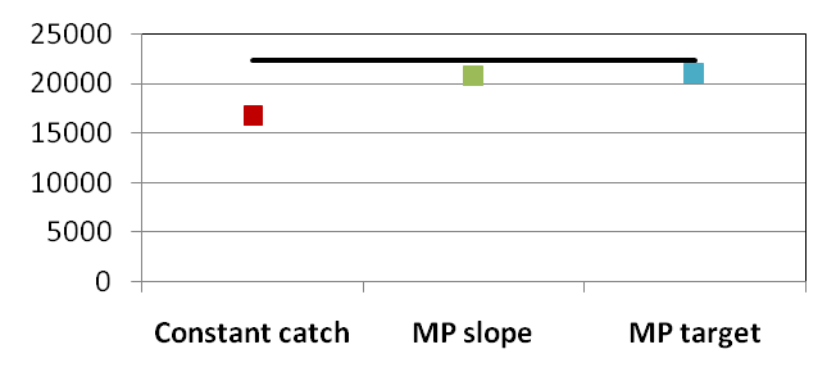
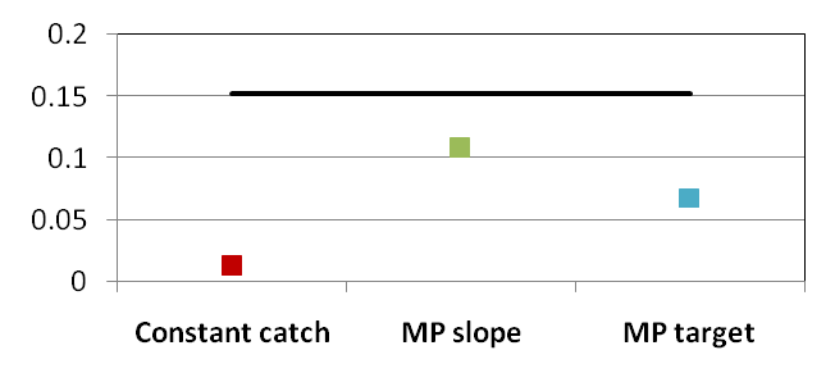
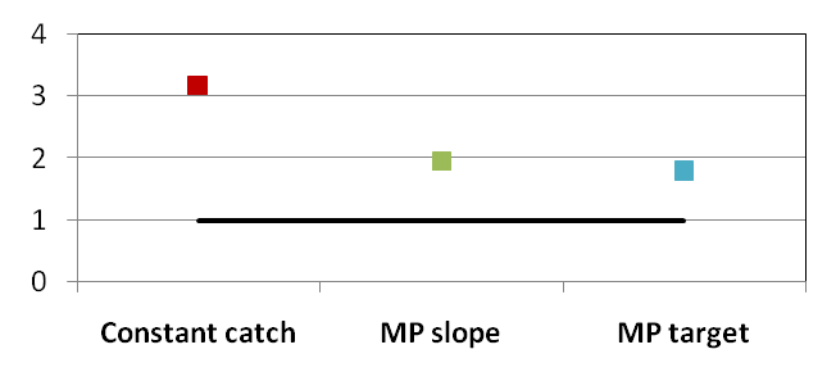


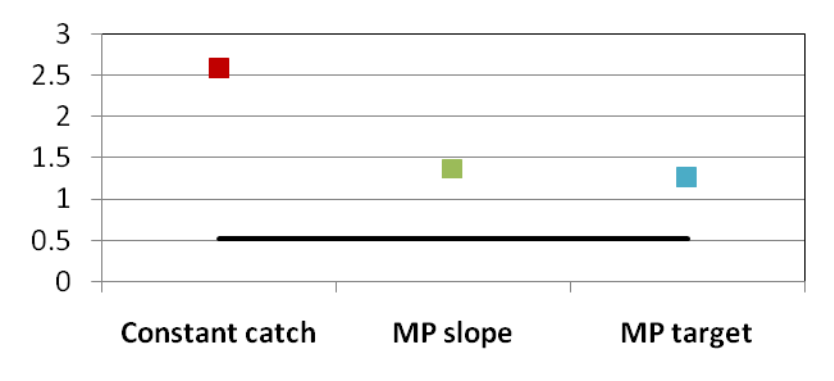
Annual average catch (tons)



Average change in catch



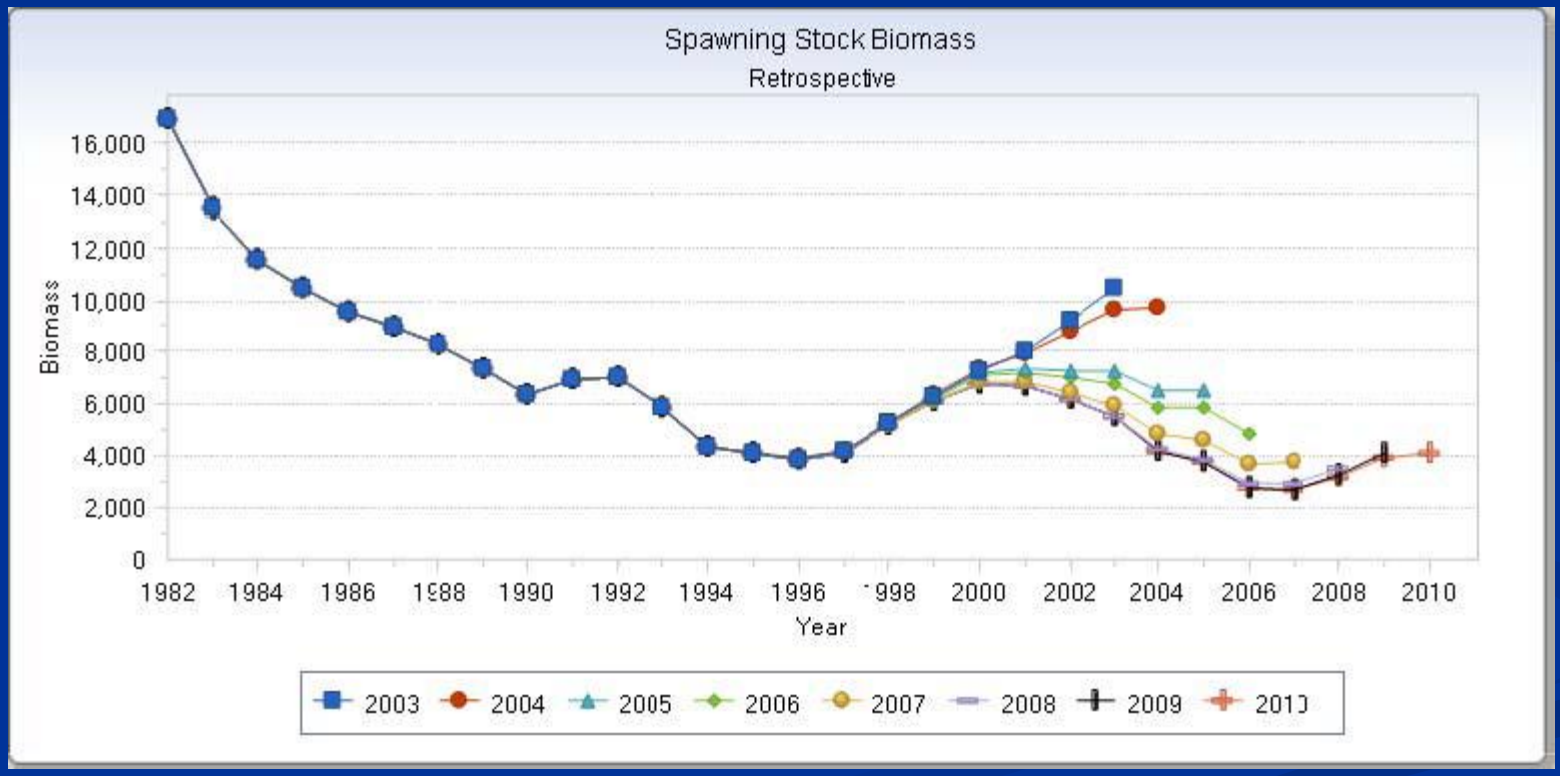
2010 SSB/SSBtarget



min SSB/SSB target

ASSESSMENTS: RETROSPECTIVE PATTERNS

Gulf of Maine Witch Flounder

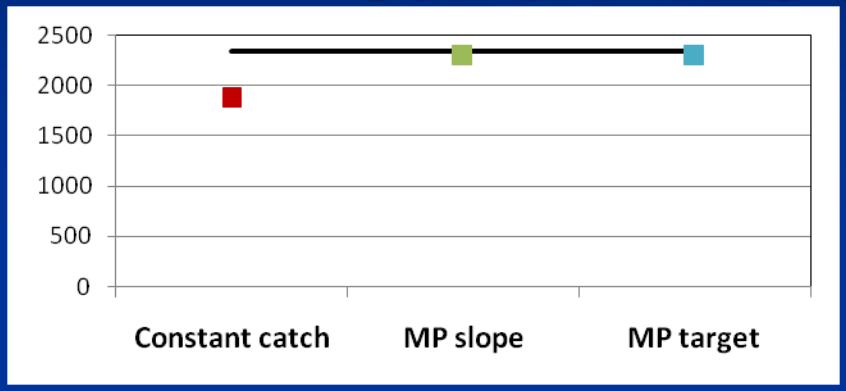


Plot copied from F. Witch Flounder by S.E. Wigley and S. Emery. NEFSC, February 2012

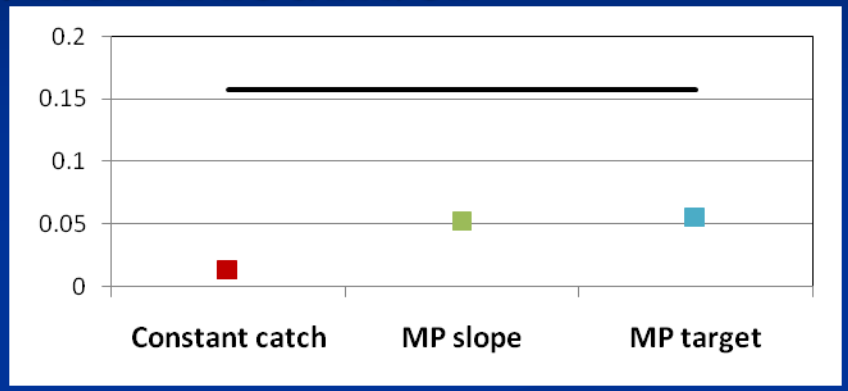
WHAT WOULD HAVE HAPPENED

COMPARISONS TO WHAT OCCURRED

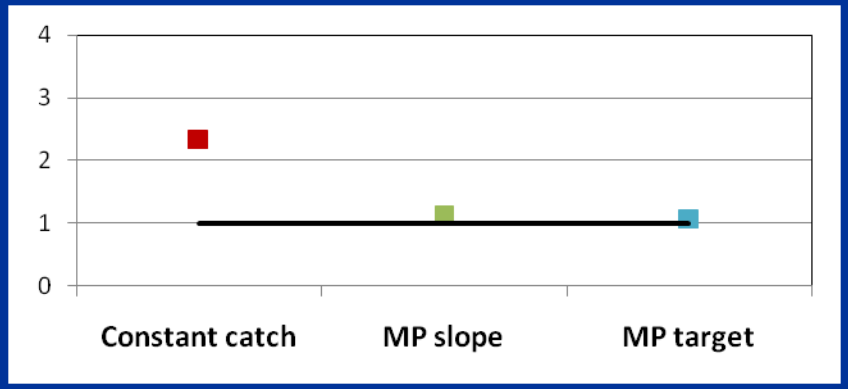
Gulf of Maine Witch Flounder



Annual average catch (tons)



Average change in catch



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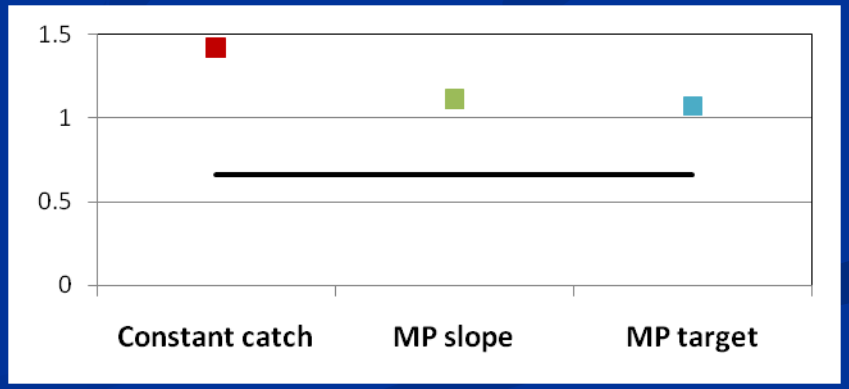


min SSB/SSB target

INITIAL CONCLUSIONS

- MPs perform as well or better than what occurred (based on annual complex assessments)
- Annual assessment based management adds unnecessary variation to management measures without reducing resource risk
- Changed role for complex assessments: provide operating models at multi-year intervals for simulation testing of these simpler MPs
- Saving on resources otherwise needed for monitoring (e.g. ageing of catch need not be annual)
- MP approach seems to be able to handle cases with relatively strong retrospective patterns

SO: PROBLEM SOLVED

USE MPs AND IT'S ALL EASY

REGRETTABLY NO !!!

MPs are designed to show robust performance to plausible uncertainties

Even with feedback, it is impossible to be robust to "everything"

How do we limit "plausibility"?

III. HOW PRECAUTIONARY?

WHAT DETERMINES HOW UNLIKELY A SCENARIO HAS TO BE BEFORE IT SHOULD BECOME CONSIDERED "IMPLAUSIBLE"

CONSISTENCY PROBLEMS

There is (implicitly) a wide range of views on this worldwide amongst scientists

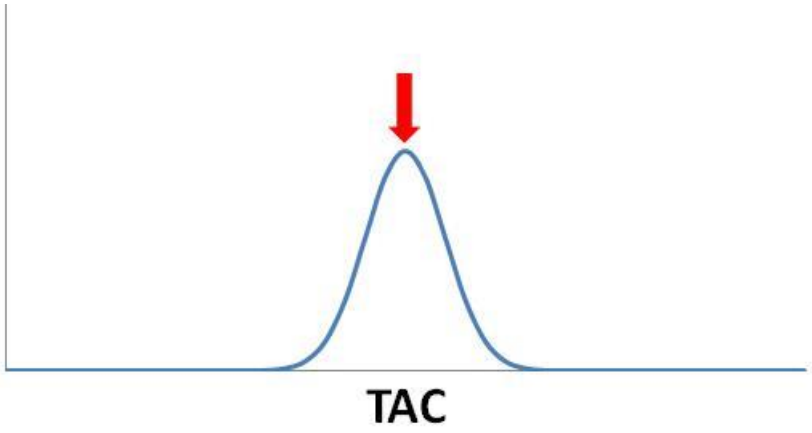
EXAMPLE I FROM THE USA

- Two *M* scenarios and two F_{MSY} proxy scenarios to effect recovery to B_{MSY} in requisite period
- Review Panel could hardly distinguish either
- TAC difference covers x[1, 2.5] range
- Panel chose most conservative option for both
- Multiplied by 75% to allow for other uncertainties
- Net reduction of 83% in TAC (later amended to 77%)
- Industry short-medium term future in CRISIS

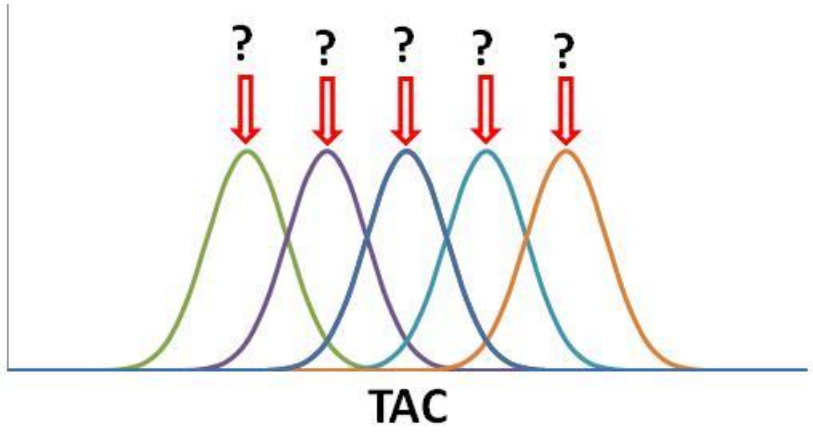
BEST-ASSESSMENT TAC ADVICE

CHARACTERISATION OF IMPLICATIONS

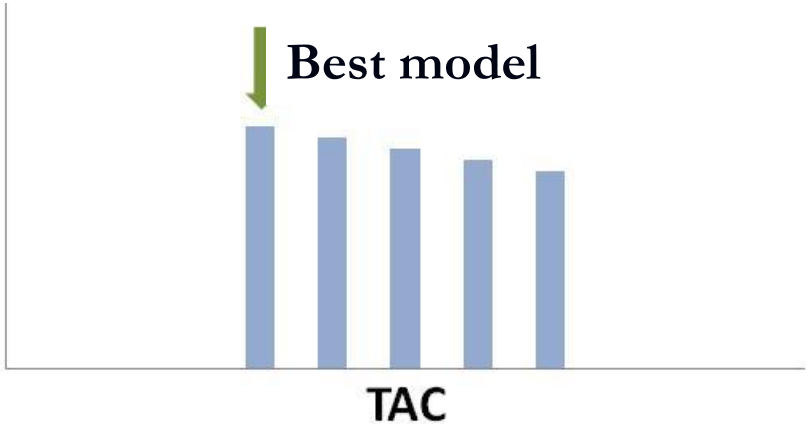
Single assessment



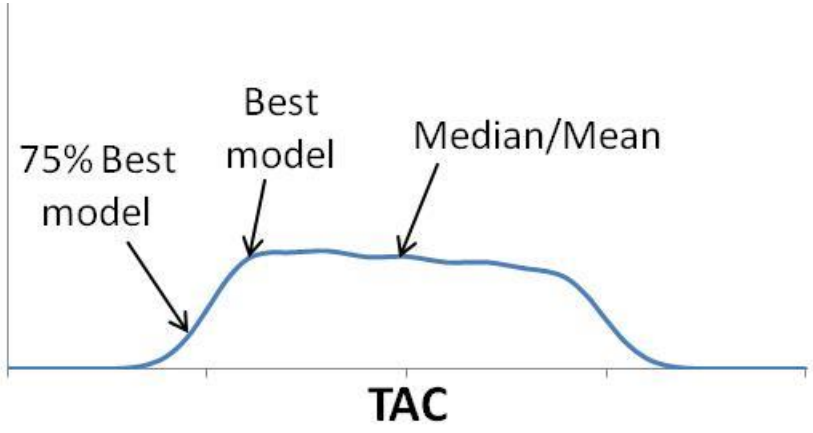
Multiple competing models



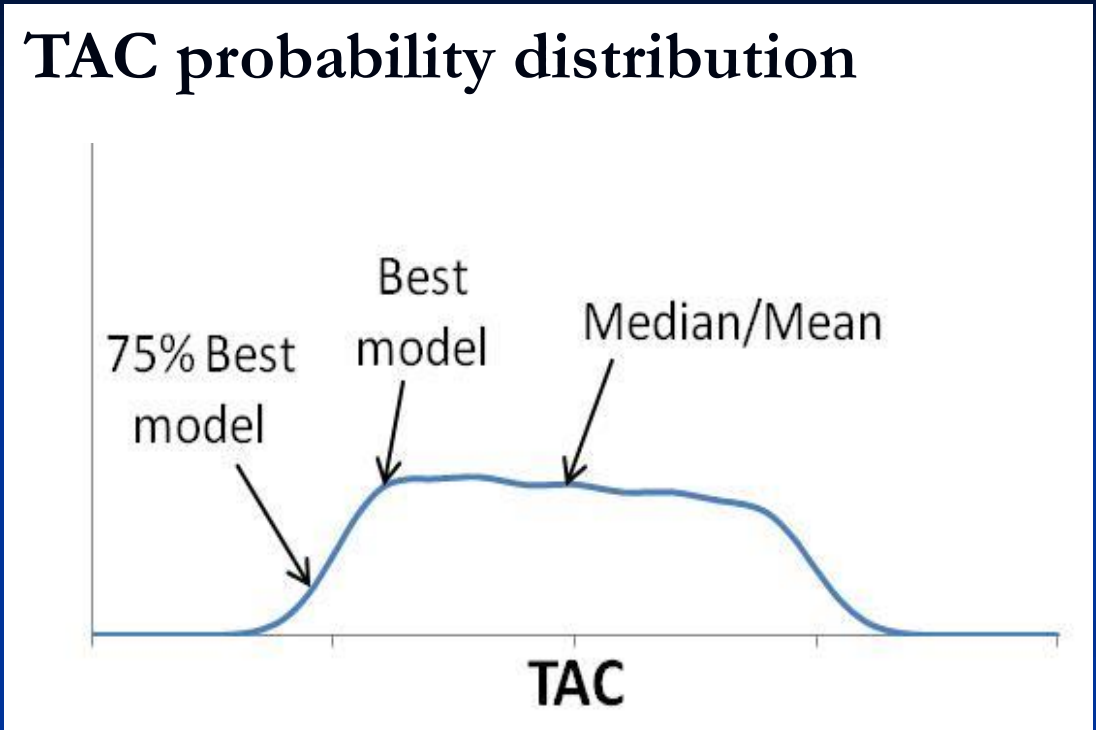
Relative weights



TAC probability distribution



BEST-ASSESSMENT TAC ADVICE



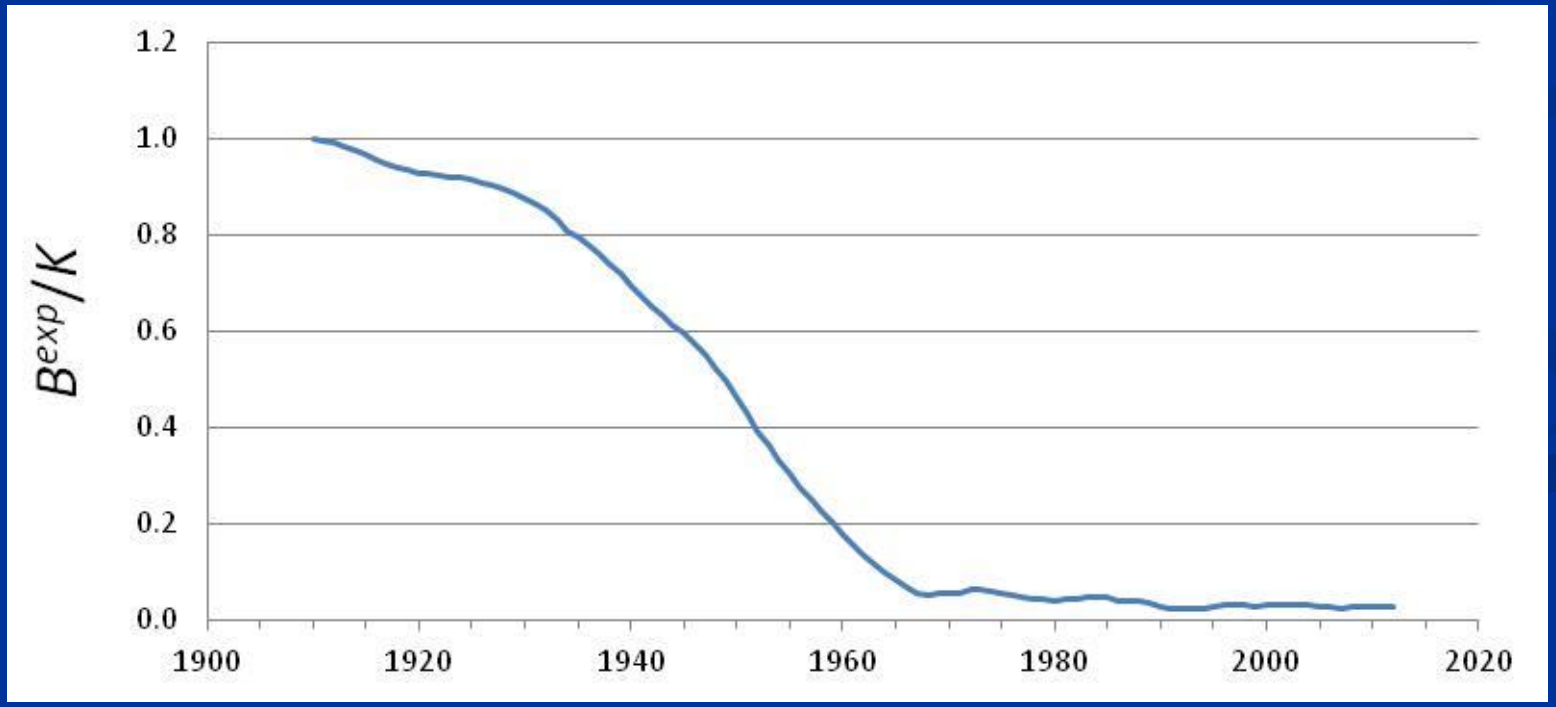
- **What's the appropriate choice?**
- **Over-layering of uncertainty 'adjustments'?**
- **Consistent with the Precautionary Principle?**

Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing ***cost-effective*** measures to prevent environmental degradation.

EXAMPLE II FROM SOUTH AFRICA

WEST COAST ROCK LOBSTER

- Resource heavily depleted in the first half of last century
- Estimated to be about 3% of pristine at present



SOUTH AFRICAN ROCK LOBSTER

- Managed under MPs for 15 years
- 2011 MP revision agreed revised recovery target over 35% by 2021 (i.e. 3% to 4%K) - trade off between extent recovery *vs* employment impact
- In 2012 Government overturned MP's 7% TAC reduction arguing "socio-economic" grounds
- First time an MP output overturned this century
- Major protests on front pages of local press from scientists and NGOs
- Green Party institutes court action to close fishery

SA ROCK LOBSTER LITIGATION

- Scientists support continued harvest under MP
- Minister announces commitment to 35% recovery, with MP to be adjusted to effect necessary TAC changes starting one year later
- Court rejects application to close fishery

"the resource has, in fact, fluctuated between 2% and 4% of pristine since about the 1960's, but notwithstanding this, the resource has continued to be fished sustainably"

"it would be totally irresponsible of the court to consider … [closing the fishery] … bearing in mind the huge financial implications and social upheaval that would be caused"

THE GREAT NORTH : SOUTH DIVIDE

(or North Atlantic : Rest of the World??)

- Would "North" scientists (and the MSC?) have considered the MP target chosen and the court judgement defensible (certification consistent)?

  More commonality on criteria for regime shift confirmation needed

- Lack of large fish in the catch:

  1) Overexploitation

  2) Domed selectivity ("hide them")

  3) Increasing *M* at large ages ("kill them")

"North" scientists are generally very reluctant to accept 2) or 3); "South" scientists accept them regularly if the data are hardly consistent with 1)

Major implications for F_{MSY} proxies based on F_{spr}%

THE GREAT NORTH : SOUTH DIVIDE

BOTH: Concern re stock status (low abundance *B*)

NORTH: Focus on getting/keeping $F < F_{MSY}$

SOUTH: Focus on getting reasonable rate of *B* increase

WHY ARE "NORTH" SCIENTISTS SO HUNG UP ABOUT *F*??!!

- Higher *B* is what matters to safeguard future recruitment, not lower *F*
- Keep *F* the same if you want constant effort, but yet you don't buy *CPUE* as proportional to *B*???
- *B* is more meaningful to stakeholders than *F*
- So what if $F > F_{MSY}$ to achieve greater catch stability, provided *B* increases reasonably?

THE GREAT NORTH : SOUTH DIVIDE

- GREAT DIFFERENCES (AMONGST SCIENTISTS) IN ACCEPTABILITY CRITERIA
- PROBLEMS ARISE FROM THIS LACK OF CONSISTENCY (e.g. for MSC certifications)

DON'T SCIENTISTS NEED TO GET THEIR ACT TOGETHER BETTER ON COMMONALITY IN HOW TO DEAL WITH UNCERTAINTIES IF THEY ARE NOT SOON TO LOSE CREDIBILITY WITH STAKEHOLDERS?

IV. SCIENTISTS – KEY PROBLEMS

MSY REFERENCE POINT ESTIMATION

In general, do we have the data to estimate MSY reliably?

Are F_{spr}% proxies defensible – how well do we know M or its age dependence?

How are regime shifts to be confirmed?

SCIENTISTS – KEY PROBLEMS

ECOSYSTEM EFFECTS (Biological interactions) AND CLIMATE CHANGE

We are unlikely to achieve models that provide quantitatively reliable predictions in the short-medium term future

Deal with via feedback control using MPs (i.e. react to changes once indicated by monitoring data)

Nevertheless important to establish coarse magnitudes of possible effects for MP evaluations

SCIENTISTS – APPROPRIATE ROLE

THE 2008 WATERSHED

NO – NOT THE WORLD FINANCIAL CRISIS

WHEN GOVERNMENT FISHERIES MINISTERS TAMELY (UNAWARELY?!) SURRENDERED THEIR AUTHORITY OVER FISHERIES POLICY IN A COUP D'ETAT BY THE BUYERS OF NORTH EUROPEAN SUPERMARKETS

NGOs persuaded these buyers not to accept fish without MSC certification

Explosion in applications for MSC certification

THE CERTIFICATION EXPLOSION

IMPLICATIONS FOR MSC

- +-30 person-days per stock per year for assessment/audit x +-250 stocks
- 30-40 person-years pa including 8-10 stock-assessment person-years pa
- MSC aims to roughly halve these figures

NEVERTHELESS:

- Only about 10% of world fisheries currently covered by MSC
- What about consistency?
  - MSC realises the importance of this
  - Plans Peer Review College: at minimum providing a pool experienced reviewers from which Certifiers can draw
  - I'd like to see an ACFM/ACOM type system of review to ensure consistency, but there are practical problems

IMPLICATIONS FOR ASSESSMENT SCIENTISTS

- Ecolabeling imposes further demands on the already stretched resource of assessment scientists
- The MSC-related needs estimates exclude the further demands on the assessment scientists for the resource itself
- This is but one example of a proliferation of assessment reviews
- A more effective use of limited resources is needed

  Fewer but more intensive reviews

  More focussed assessment reports (not 'many hundreds of pages')

  The answer is NOT in training more people to undertake 'black box' assessments. Assessments are complex and need experts in the field. Rather train people in the implementation of simple MPs developed by experts

SCIENTISTS – APPROPRIATE ROLE

THE NATURE OF ADVICE PROVIDED

Wide confusion internationally

RFMO quotes

"If scientists provide options, the Commission will ask which of these options the scientists recommended"

"My Commissioner insists that the Scientific Committee recommend a single TAC" (Difficult when other Commissioners had insisted that their delegations ensure an outcome consisting of no more than the implications of a range of options!!!)

"Correct" approach is to give implications of a range of options for choice by decision makers

Scientists (justifiably??!!) mistrust managers' understanding and often play games – their preferred option is placed in the centre of the range

WHO MAKES THE BEST CONTRIBUTION TOWARDS SUSTAINABLE MANAGEMENT?

Big industry (Alphabetic)

Managers

NGOs

Scientists

Small industry

LIKELY ORDERING BY THE PUBLIC

NGOs

Scientists

Managers

Small industry

Big industry

WHO MAKES THE BEST CONTRIBUTION TOWARDS SUSTAINABLE MANAGEMENT?

Big industry

Can financially afford a longer time horizon (lower discount rate)

Managers

Turn over too quickly to master the concepts

NGOs

Their funding models often require continual "new" issues

Small industry

Can't afford cutbacks financially (short time horizon, high discount rate)

WHO MAKES THE BEST CONTRIBUTION TOWARDS SUSTAINABLE MANAGEMENT?

Scientists

Current US Law gives them (Scientific and Statistical Committees) primary authority

A great opportunity, but are we up to the task?

I have not been too impressed by the knowledge and responsibility evidenced by some of the comments I've heard from some members of such groups

Think carefully – if you had your life's savings invested in a fishing company, would you be happy to leave the major decisions affecting your future in the hands of a typical group of scientists ?

WHO MAKES THE BEST CONTRIBUTION TOWARDS SUSTAINABLE MANAGEMENT?

SO WHAT'S MY ORDER?

YOU CAN ASK ME LATER

BUT I'LL PLEAD THE 5TH

V. LOOKING AHEAD

OBJECTIVES

- **Drop MSY-related targets UNLESS these are reliably estimable directly**

  Set targets in terms of "observables" – past CPUE or survey abundance levels – until reliable MSY estimation becomes possible

  Select recovery rates to targets based on the trade-off between catch/employment reduction *vs* rate of biomass increase

- **Drop *F*-based targets, to be replaced by a focus instead on biomass rate of increase and low levels of inter-annual TAC variability**

LOOKING AHEAD

ASSESSMENTS

- Single "best assessments" are not consistent with "best scientific information available" – very seldom can a single model be considered to reflect the range of scenarios compatible with available information
- There's a need to move to use of multiple models

  Not necessarily model averaging

  Primarily "risk analysis" – compare the implications of different management actions across a representative range of models

LOOKING AHEAD

MANAGEMENT PROCEDURES

- The longer analysis time requirements and lack of expertise will limit large scale introduction
- Nevertheless worth considering applications of very simple MPs further
- Their greatest potential is in management of data-poor stocks for which generic MPs need to be developed urgently

LOOKING AHEAD

SCIENTISTS - Need to improve

- Consistency in the treatment of uncertainties
- Responsibility (greater breadth of consideration) in developing advice
- Communication with stakeholders

Scientific training correctly emphasises thoroughness, a defence of assumptions, and an explanation and justification of methodology

Presentations to stakeholders usually require exactly the opposite!

Thank you for your attention

With acknowledgements for discussions and/or assistance with presentation preparation (but WITHOUT implying any co-responsibility for comments made!!):

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