General comments by Dr. Kuriyama

1. Please describe the methods for combining F (and Fmsy) values across ages. ･･
    a. The F values for the plus group and the age class before often have identical F values. ･･Please correct me if I am misinterpreting or provide more detail.
    b. Another concern is that the F values for older age classes can become very high. ･･My concern is that some of the F values (and F/Fmsy ratios as a result) could be biased high.
2. I think there are often some difficulties with assuming the data represent a closed population. An integrated catch-at-age analysis (which can be modeled with Stock Synthesis) may offer a better ability to make the model assumptions more explicit.･･
    a. ･･In a VPA the assumption has to be that each of the fleets have the same "selectivities," although this is treated as age-specific F.
    b. An additional benefit will be to estimate the uncertainties associated with the data and model estimates.･･
3. I recommend including more detail and description of the data used in the assessments.･･
4. The decisions to use fixed M values should be detailed a bit more.･･
    a. I also recommend including more description of the decision to use a time-invariant M value rather than an age-specific M value.･･
5. Please double-check that the catch values reported in the tables and used for the stock assessments all match.･･

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事前の文書レビューでKuriyama博士から5つの項目の全般的なコメントをいただきました。
各魚種の議論に入る前に、ここで私から一通り説明させていただきますが、それぞれの項目の具体的な質疑、議論については、このあとの各魚種のセッションや、最後の総合討論のなかで、各項目の専門家、担当者が対応しますのでよろしくお願いします。

In the preliminary document review, Dr. Kuriyama provided general comments on five items.
Before we move on to the discussion of each fish species, I would like to provide a general explanation here. However, specific questions and discussions on each item will be handled by experts and staffs in charge of each item in the sessions for each fish species to come and in the general discussion at the end, so thank you for your cooperation.

1. Please describe the methods for combining F (and Fmsy) values across ages. I thought that in most cases they would be averaged together, but I could not get my calculations to match the values reported in the documents.

- Because we used age-structured model (VPA), fishing mortality coefficients used in the population dynamics models (for estimation model and future projection model) are age-based fishing mortality (i.e. $F_{a,y}$)
- Fmsy is also defined as a vector of fishing mortality coefficient as $F_{a,\mathrm{MSY}}$
- When we have to evaluate the relative impact of $F_{a,y}$ to $F_{a,\mathrm{MSY}}$ (F/Fmsy or Fmsy/F) as a single value, the value is calculated by considering F%SPR as:

$$F_{a,MSY} \rightarrow F_{36\%SPR}$$

$$F_{a,y} \rightarrow F_{50\%SPR}$$

$$xF_{a,y} \rightarrow F_{36\%SPR}$$

Here, x is expressed as Fmsy/Fy
(1/x is Fy/Fmsy as y-axis of Kobe plot)

※ This method can work even when selectivity is different between the two vector of F
※We're sorry that there are no enough explanation of the method for conversion.
※ Values calculated from other combining methods (e.g. simple average) of $F_{a,y}$ might be shown in some figures and tables in the assessment report, but these values are not used for stock status evaluation

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Momoko ICHINOKAWA
As the first major comment, Dr Kurihara raised 3 issues as shown here. I answer these issues one by one.
コメント1について
我々が資源評価で用いているVPAは年齢構造モデル（age-structured model）なので、資源量推定や将来予測で用いる個体群動態における漁獲死亡係数は全て、年齢別になっています。同様に、Fmsyについても、Fa,MSYのように、年齢別のベクトルになっています。ある年の漁獲圧をFmsyに対してどのくらい強いかを評価したい場合には、Fを%ＳＰＲで換算することで行っています。具体的には、Fmsyに相当する%ＳＰＲを計算しておいてから、評価したい特定の年のFの%SPRを計算し、これを何倍すればFmsyに相当する%ＳＰＲになるか、という値（ｘ）を計算しています。そしてこのｘをFmsy/Fに相当する数字として示しています。神戸プロットのｙ軸にあたる値（F/Fmsy）については1/xです。
※この方法であればFベクトルの選択率が異なっていても利用できます
※評価レポートに詳細な記述がなかったことをお詫びします
※他の手法で計算された値（例えばFの平均値など）が報告書に掲載されている場合もありますが、それらの数字は漁獲圧の評価のためには用いていません

a. The F values for the plus group and the age class before often have identical F values. Based on the equations provided in the appendices, this seems like it should only occur if the catch values for the two age classes are the same. Please correct me if I am misinterpreting or provide more detail.

- Generally, some kind of assumption is necessary for the **Fs in the terminal year and plus age** in VPA because of its backward nature

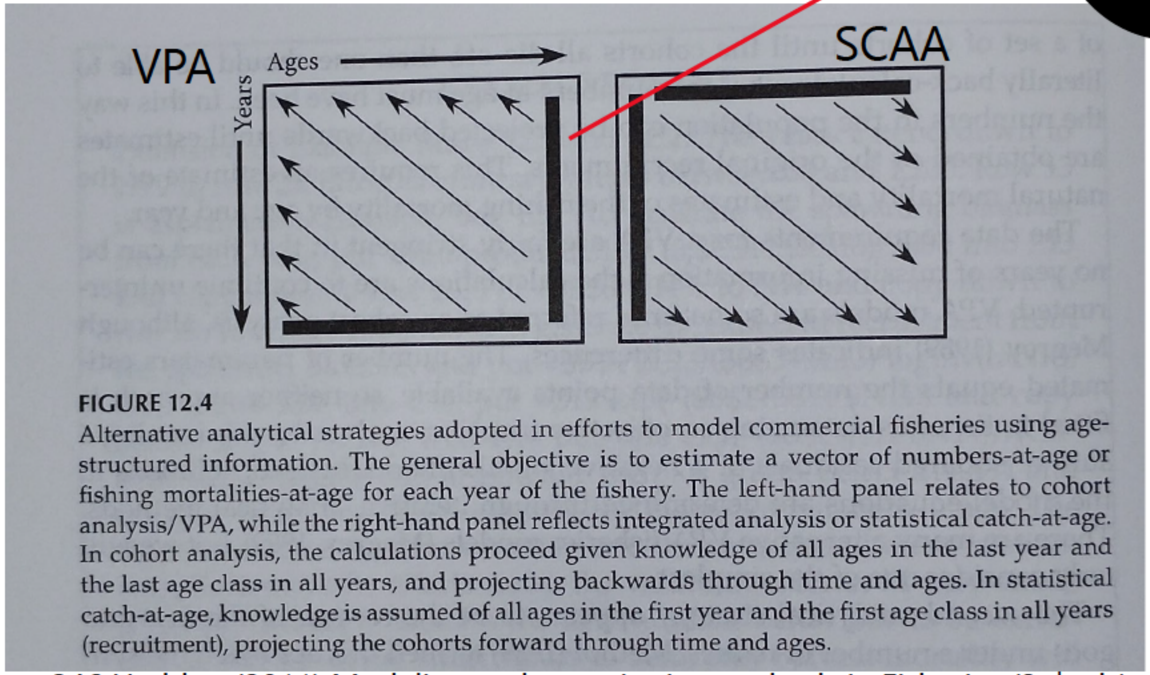

FIGURE 12.4
Alternative analytical strategies adopted in efforts to model commercial fisheries using age-structured information. The general objective is to estimate a vector of numbers-at-age or fishing mortalities-at-age for each year of the fishery. The left-hand panel relates to cohort analysis/VPA, while the right-hand panel reflects integrated analysis or statistical catch-at-age. In cohort analysis, the calculations proceed given knowledge of all ages in the last year and the last age class in all years, and projecting backwards through time and ages. In statistical catch-at-age, knowledge is assumed of all ages in the first year and the first age class in all years (recruitment), projecting the cohorts forward through time and ages.

p. 346 Haddon (2011) Modeling and quantitative methods in Fisheries (2nd eds)

In Japanese VPA, we estimate the F values with the following constraints:

1. **Assumption of F at plus group ($F_{A,y}$) = F at plus grop -1 ($F_{A-1,y}$) (for all stocks)**
2. F at age in the terminal year is the same as the average F at age in the last some years (except the terminal year) [when abundance indices are not available (e.g. amberjack)]
3. F at plus age and terminal year is estimated by using abundance indices and the assumption of some kind of selectivity (e.g. Pacific cod)
4. Estimate all Fs at the terminal year by using abundance indices (no case in this reviewed stocks)

Thus, the F values for the plus group and the previous age class are identical due to the assumption of (1). If F is assumed to be identical, the relative difference in catch values of the two age classes can be used to infer the relative difference in abundance of the two adjacent cohorts (=recruitment).

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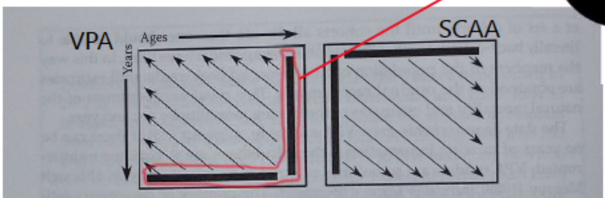

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Momoko ICHINOKAWA
VPA（Virtual Population Analysis）における後ろ向き計算（backward calculation）の性質のため、VPAでは、最終年およびプラスグループのF（漁獲係数）に何らかの仮定が必要です。日本のVPAでは、以下の制約条件の下でF値を推定しています。
•まず、全ての魚種に適用する仮定としては、プラスグループ（最も高齢の年齢層）におけるF値（$F\_(A,y)$）は、その1つ下の年齢層におけるF値（$F\_(A-1,y)$）と同じであるというものです
•また、資源量指数が利用できないブリのような場合、資源評価最終年（terminal year）における各年齢層のF値は、過去数年間（ただしterminal yearは除く）の各年齢層でのFの平均値と同じとしています
•資源量指数が利用できるタラのような場合、terminal yearのF値は、資源量指数と特定の選択性（例：太平洋ダラの場合など）の仮定に基づいて推定します
•資源量指数が多くの年齢で利用できる場合には、terminal yearの全ての年齢のF値を独立に推定することもありますが、今回のレビュー対象魚種では該当ないです。
(1)の仮定により、VPAではプラスグループとその1つ下の年齢層のF値は同一と推定されます。F値が同一と仮定することで、この2つの年齢の漁獲尾数の相対的な差異を用いて、隣接するコホート間の資源尾数（＝加入尾数）の相対的な大きさを推定することができます

b. Another concern is that the F values for older age classes can become very high. Some of these stocks have relatively specific distribution boundaries and my sense is that some of these older fish might be moving out of the boundaries rather than caught in the fisheries. VPA doesn't really have "selectivity" in which the authors could specify a selectivity curve that has very low (~0) selectivity values for these older fish. My concern is that some of the F values (and F/Fmsy ratios as a result) could be biased high.

- The concern ("emigration of older fish would cause overestimation of F in older fish") might be true in some stocks. Even in VPA, it is theoretically (but partially) possible to consider the effect of emigration by extending the assumption of $\boldsymbol{F_{A-1,y}} = \boldsymbol{F_{A,y}}$ to $\boldsymbol{F_{A-1,y}} = \boldsymbol{\alpha_y F_{A,y}}$. However, because it is difficult to estimate $\boldsymbol{\alpha_y}$ without reliable age-specific abundance indices at older ages, the value is assumed as 1 in most cases, precautionarily [smaller α result in higher abundance estimation].
- However, in a stock of jack mackerel, $\alpha = 0.2$ is assumed considering its fishery and biological characteristics [older fish move to deeper water],
- Sensitivity analysis on the assumption of α is recommended routinely to be conducted.

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Momoko ICHINOKAWA
・「高齢魚の移出(emigration)により高齢魚の漁獲圧が過大評価される可能性がある」という懸念は、いくつかの魚種において当てはまる可能性があります。理論的には、VPAにおいても$\boldsymbol{F}$_$(\boldsymbol{A}-\boldsymbol{1},\boldsymbol{y})$=$\boldsymbol{F}$_$(\boldsymbol{A},\boldsymbol{y})$という仮定を拡張して、$\boldsymbol{F}$_$(\boldsymbol{A}-\boldsymbol{1},\boldsymbol{y})$=$\boldsymbol{\alpha}$（アルファ）_$\boldsymbol{y}$ $\boldsymbol{F}$_$(\boldsymbol{A},\boldsymbol{y})$とすることで移動の影響を部分的に考慮することは可能です。しかし、高齢魚に対する信頼性の高い年齢別資源量指数がない場合、$\boldsymbol{\alpha}$（アルファ）_$\boldsymbol{y}$の推定が難しく、予防的な観点から通常は1と仮定しています（αアルファが小さいと資源量の推定が大きくなてしまうためです）。
・一方で、マアジのように「高齢魚が深場へ移動する」という漁業および生物学的特徴を考慮し、α=0.2と仮定される例もあります。
・αの仮定に対する感度分析は、定期的に実施することを推奨しています。

Response to general comments 2

- **Assumption of closed population in VPA**
  - Doesn't SS usually assume a closed population?
  - Can area specific SS be built and can interaction between multiple SS models be considered?
  - If so, we would like to learn from your case studies

- **Assumption of selectivity**
  - As the VPA does not treat catch-at-age by fishery type, it does not assume the same selectivity for each fishery type
  - The VPA accounts for different types of fisheries by assuming age-specific F

- **Consideration of uncertainty into catch-advice**
  - To account for uncertainty, an adjustment factor(β=0.8) is proposed for the catch advice based on MSE simulations

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Mitsuyo MIYAGAWA
General comments2への返答です.
まず，VPAが閉じた個体群を仮定しているということに関してですが，SSも一般的には閉じた個体群を仮定しているのではないでしょうか？
それとも，エリア別のSSモデルを作成し，エリア間での交流をSSは考慮できるという意図でのご意見でしょうか？
もしそうであれば，参考となるケーススタディーなどをご紹介いただけるとこちらの勉強にもなりありがたいです.

次に，漁業形態別の選択率についてですが，VPAでは漁業形態別に年齢別漁獲尾数を扱っていないので，そもそも漁業形態ごとに同じ選択率を仮定しているわけではありません. 複数の漁業形態を加味したうえで，年齢別のFとして扱っています.

最後に，不確実性の考慮に関してですが，算定漁獲量を計算するにあたって不確実性を全く考慮していないわけではありません. 不確実性を考慮にいれたMSEを行い，そこで提案された調整係数（$\beta=0.8$）というものを乗じて算定漁獲量の調整を行っています.

Launch of New Project

- **Theme I: Increasing the accuracy of data fundamental to stock assessment**
  - Group IA: Improvements in biological parameters/characteristics
  - Group IB: Improvements in catch-at-age data
  - Group IC: Improvements in natural mortality estimates
  - Group ID: Development of abundance indices
  - Group IE: Utilization of digital image analysis data

- **Theme II: Development/application of stock assessment models**
  - Group II-1: Application of SAM (state-space age-structured model)
  - Group II-2: Application of SS (stock-synthesis)
  - Group II-3: Consideration of multi-species stock assessment models

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Mitsuyo MIYAGAWA
しかし，Peterさんのコメント２における問題意識は我々も充分に認識しており，今年度から新しいプロジェクトを立ち上げたところです．このプロジェクトのテーマ２は資源評価モデルの開発に関してであり，より不確実性を考慮した資源評価が行えるよう，SAMやSSなどを適用できる環境を整えている最中であり，本プロジェクトは数年かけて行う予定でいます．第1回目にピアレビューを受けたマサバ太平洋系群では，本年度より，VPAからSAMに資源評価モデルが本格的に移行される予定です．

General comments:

3. I recommend including more detail and description of the data used in the assessments. Specifically, the data used to relate lengths to ages and weights to lengths. I recommend including the number of observations and the data source (specific to purse seine fishery, bottom trawl fishery, bottom trawl survey for example). It was difficult in most cases to determine how lengths were converted to ages. This is very important as age data are a key component of these models, and I don’t think there is a way to incorporate uncertainty in the age-length relationships or age observations in the models.

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コメント3について
評価に使用したデータの詳細と説明を記載するように、とのご指摘をいただきました。補足資料を追加するなど、できるだけ詳しく記載するようにしていきたいと考えています。このあとの各魚種のセッションではそれらの具体的な方法を説明し、議論いただきたいと思います。

Comment 3:
We had your suggestion to provide details and explanations of the data used in the assessment. We would like to provide as much detail as possible in the next year report, including adding appendix. In the sessions for each species that follow, we would like to explain the specific methods and have them discussed.

General Comment #4

Detailed info on M

Japanese stock assessments generally use M estimator by **Tanaka (1960)**.

Decision behind this selection is to use standardized M estimator among stocks unless additional information is available.

We are currently working on a project to establish a guideline to select M based on the available information to improve the value of M.

M=2.5/Amax

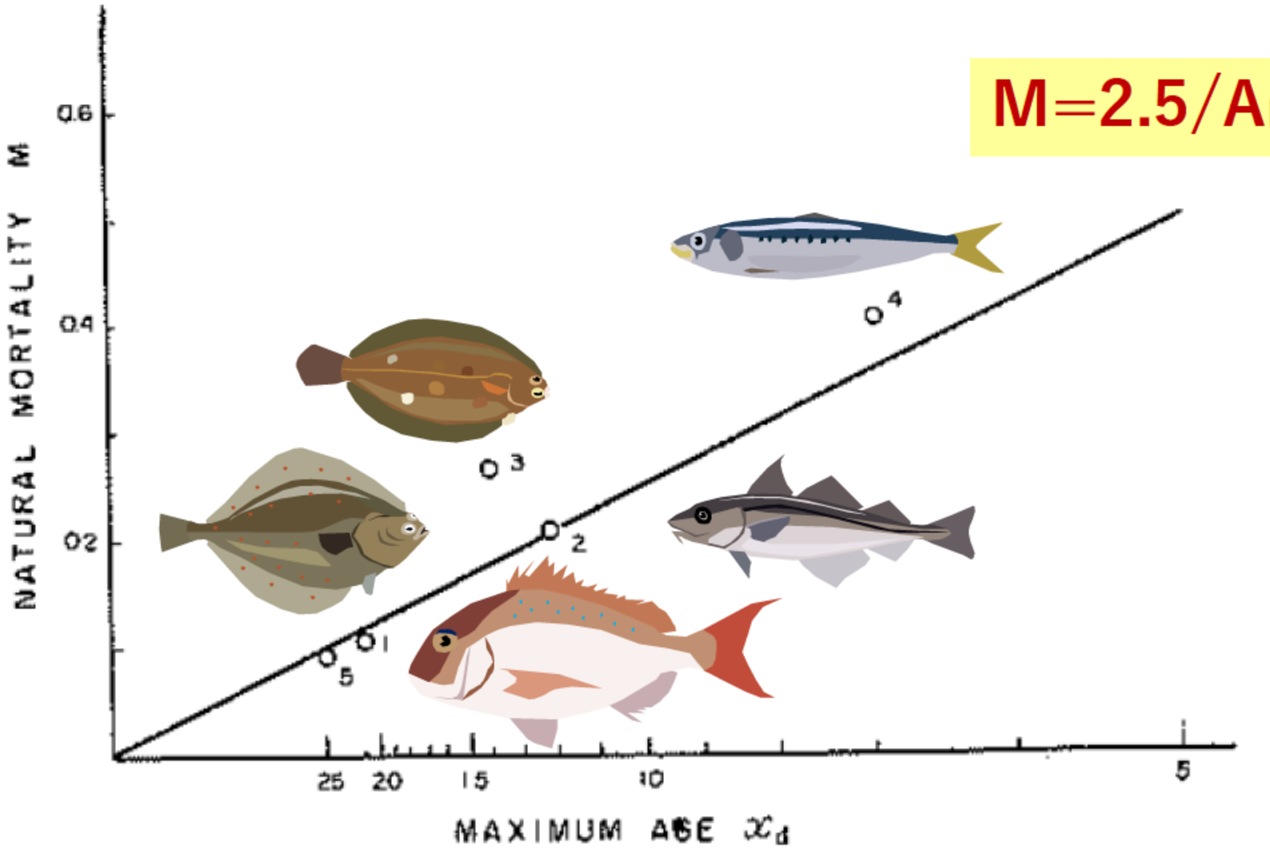

Fig. 5.27 Relation between length of life span and natural mortality. (1) North Sea, plaice. (2) North Sea, haddock. (3) British Columbia, lemon sole. (4) California, sardine. (5) Inland Sea, Japan, red porgy, *Chrysophrys major*.

Tanaka (1960)

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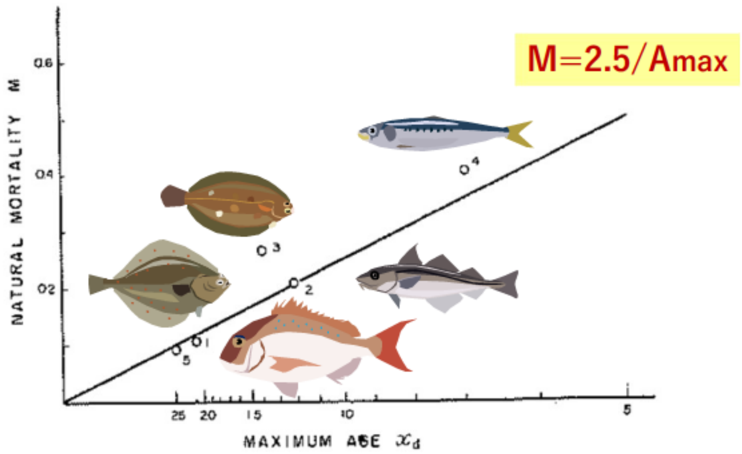

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Tanaka (1960)

Akihiro MANABE
コメント4について
日本の資源評価は通常、田中（1960）のMの推定式を用いています。この数式を利用する理由としては、各資源評価で共通の数式を用いることが挙げられますが、別途情報がある場合は別の数式を使うこともあります。右は田中(1960)で用いられている数式M=2.5/Amaxの図です。ここでは底魚４種、浮魚１種のデータを用いて近似線が引かれています。2.5/寿命という数式がHamel and Cope(2022）と大きく異なる理由としてはフィッティングに用いたデータの少なさがあると考えています。我々も、この数式を使い続けるのではなく、現在、資源評価の高精度化を目指すプロジェクトの中で、Mの選定についてのガイドラインを作成検討しています。

M distribution and current M

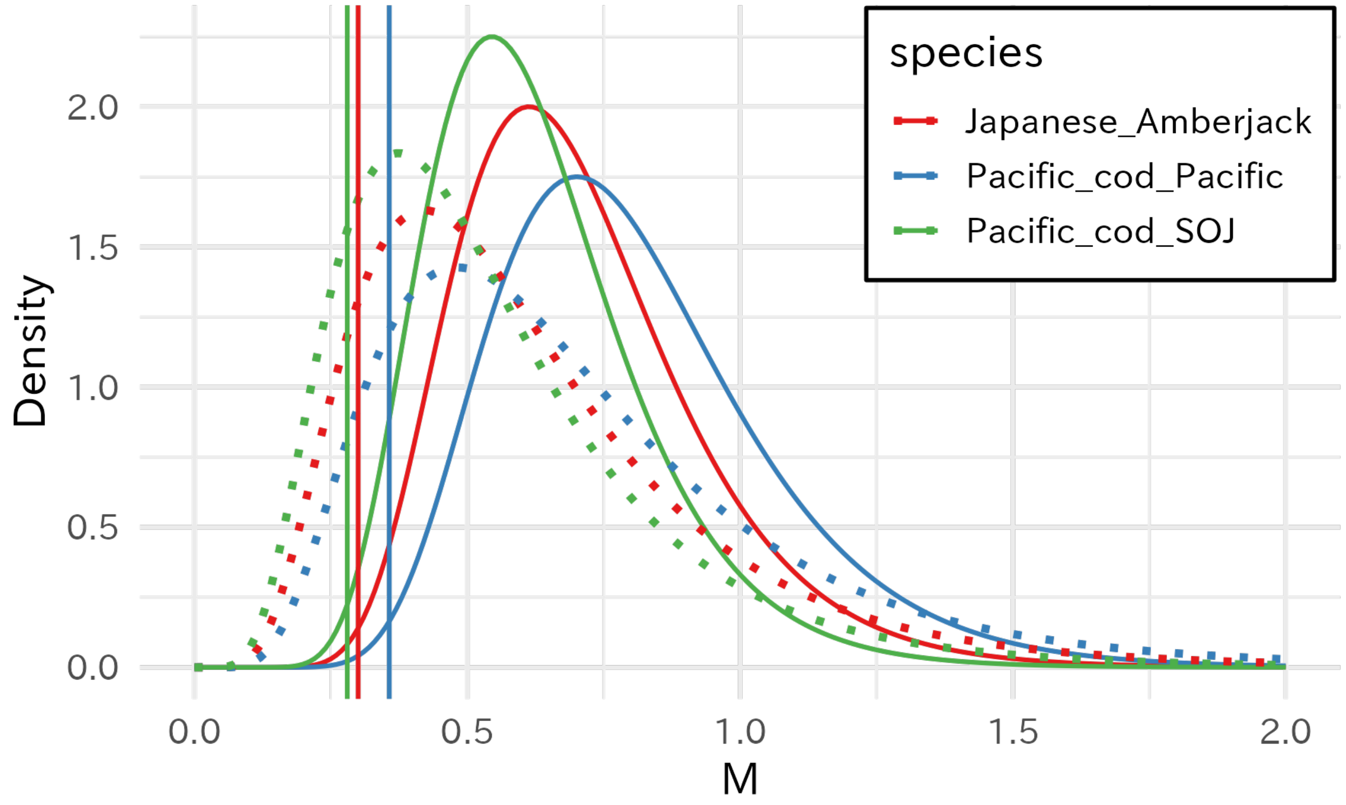
The prior around M ends up being relatively wide. Generally, this calculation is 5.4/maximum age in the data.

VPA requires a single M/yr/age.

Tanaka (1960) estimates low M compared to other two methods.

All three species are within the 95% confidence interval based on **Hamel (2015)** but not for **Hamel and Cope (2022)**.

We acknowledge the importance of M and its distribution, which can be used for sensitivity analysis.



Solid = Hamel and Cope (2022)
Dotted = Hamel (2015)
Vertical = Tanaka (1960)

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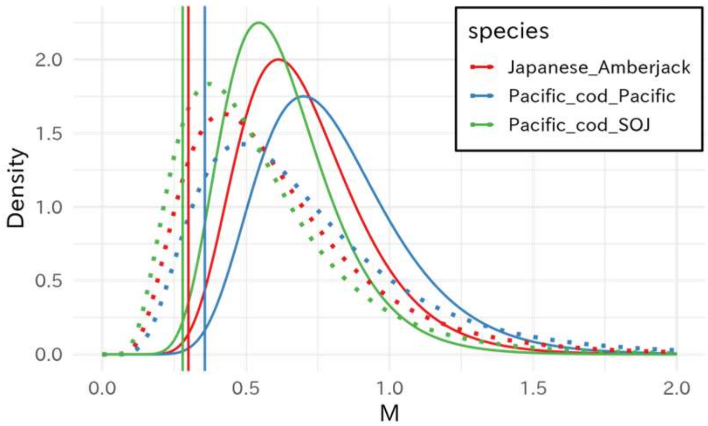
VPA requires a single M/yr/age.

Tanaka (1960) estimates low M compared to other two methods.

All three species are within the 95% confidence interval based on **Hamel (2015)** but not for **Hamel and Cope (2022)**.

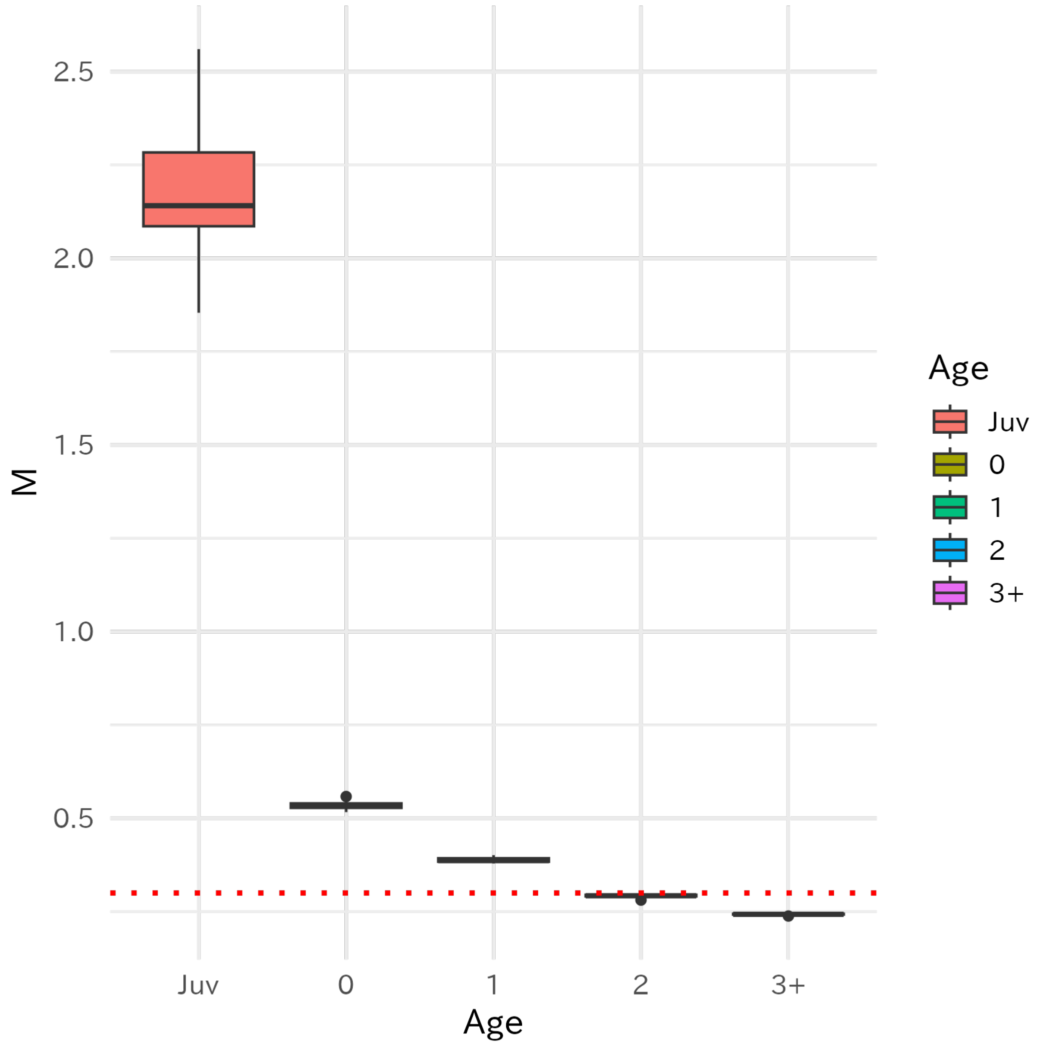
We acknowledge the importance of M and its distribution, which can be used for sensitivity analysis.



Solid = Hamel and Cope (2022)
Dotted = Hamel (2015)
Vertical = Tanaka (1960)

Akihiro MANABE
アメリカではMが事前分布として与えられることについては認識していますが、VPAでは各年、各年齢で決まった値を入れて資源を推定します。そのため、現状では分布の形をとるMは導入できていません。また、指摘にもありましたHamel and Cope (2022）のMやHamel (2015）のMと比べても現在の資源評価で用いている田中(1960）のMは低く推定されています。右の図は実線がHamel and CopeによるMの分布、点線がHamelによるMの分布、垂直線が田中のMとなります。Hamel(2015)の場合は95%信頼区間の中に田中のMが入りますが、Hamel and Copeの場合には入らず、田中のMが低いということが認識できました。これらの点を考慮して、現在行われている高精度化プロジェクトの中で、Mの推定の改善を行いたいと考えています。また、Mの分布から感度分析に用いるMの値についても改善していきたいと考えています。

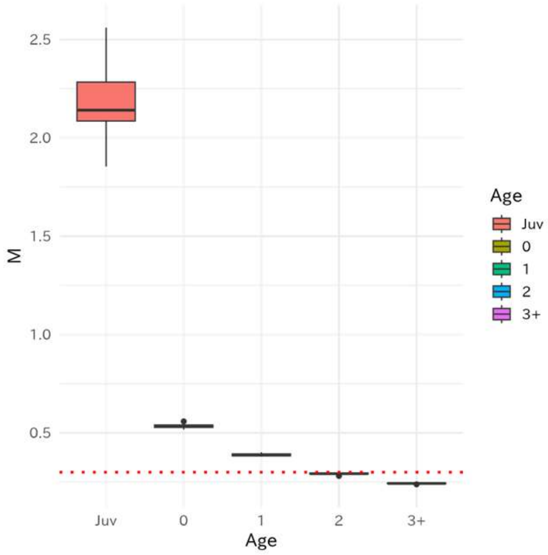
Age specific M



e.g.) Japanese amberjack

- Age (size) specific M is utilized in some stock assessments and considered in Japanese amberjack with Gislason et al. (2010).
- **Lorenzen's M** typically provides lower M than Tanaka (1960) in older ages.
- **Is there any example which age specific M is utilized in the United States?**

Age specific M



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- **Is there any example which age specific M is utilized in the United States?**

Akihiro MANABE
年齢別、サイズ別のMはいくつかの資源評価では使われており、本日議論の対象となりますブリでもGislason（ギスラソン）のMを用いてモジャコのMを比較検討しています。この左の図はLorenzen（ローレンゼン）の式に基づいたブリのMの年齢別のボックスプロットです。年別の平均体重についてMを計算しています。ここから読み取れるように、LorenzenのMは高齢では田中のMよりも低い値を示すことがあります。アメリカではこの年齢別Mを用いているようなケースがあるのでしょうか？どのように用いているのか、情報共有などをしていただけますと助かります。

Renewing the longevity

Although the source of longevity is recent in the three peer reviewed stocks, we recognize the importance to estimate longevity based on the newer data.

Species	Longevity	Source year
Japanese amberjack	7 or 9	2019, 2016
Pacific cod – Pacific	7	Observation
Pacific cod – SOJ	9	2019

We are currently working to improve/refresh the life history parameters.

It would be helpful to learn how longevity is estimated in the United States.

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Akihiro MANABE
Mの推定に係わる寿命についても、その推定方法やいつ推定されたかによって、更新を行うことの重要性を認識しています。今回のピアレビューで扱われる３系群の寿命のソースはどれも近年のものであり、漁獲物による観察などから推定されています。しかし、他の系群などについても引き続き寿命の更新などを行う必要性があると感じています。現在、高精度化プロジェクトの中で生活史パラメーターの改善や更新などが行われています。アメリカではどのような手法で寿命を推定しているのか、その手法について学ぶことができれば、我々にとって大きな改善への一歩となることが期待されます。

General comments:

5. Please double-check that the catch values reported in the tables and used for the stock assessments all match. In some cases, I found discrepancies that were greater than might be expected from rounding (~60 mt).

The values shown in the table in the report have been rounded. The sum of the values in each column may not equal the value shown in total cell.

example	true	rounding	report
	10.3	→	10
	20.3		20
	30.4		30
	40.4		40
	50.4		50
total	151.8	→	152

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最後のコメント5について
漁獲量などの数値は資源評価の解析に使うにあたり、複数のスタッフで確認をおこなっていますが、あらためて確認します。
ご承知とは思いますが、報告書の表の数値は実際の値を四捨五入して示しているので、スライドに仮の値で例を示しているように、各列の数値の合計と、合計の欄の数値が合わない場合があります。
いただいたコメントで、報告書の表で四捨五入によって予想されるよりも大きな差異が見つかったとのことですが、どの表のことか指摘いただければ、確認して必要があれば修正します。

The last comment 5
Multiple staff members check figures such as catch values before using them in the stock assessment analysis, but we will check them again. As you are aware, the figures in the tables in the report are actual values that have been rounded off, so as shown in the example with provisional values on the slide, the total of the figures in each column may not match the figure in the total column.
In your comment, you said that a larger discrepancy than expected due to rounding was found in the tables in the report. If you could point out which table you are referring to, we will check and make corrections if necessary.