Extinction risk assessment of Japanese vascular plants and its application to Environmental Impact Assessment for Aichi EXPO 2005

Thanks to:
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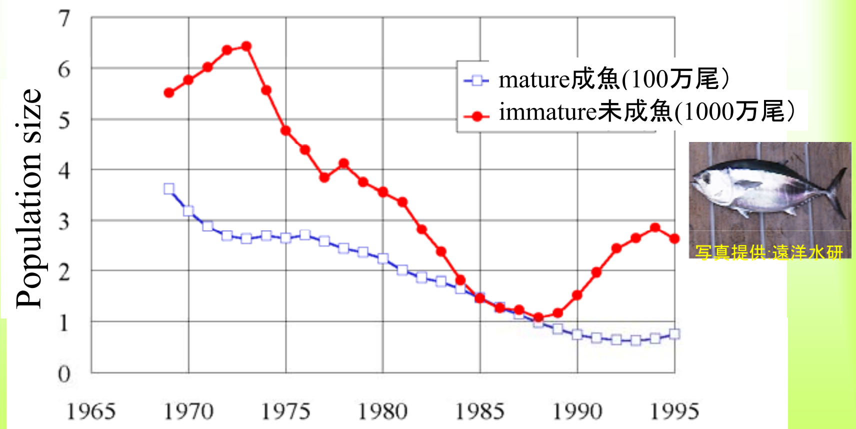
T. Kato
S. Serizawa
K. Ueda
Organizers

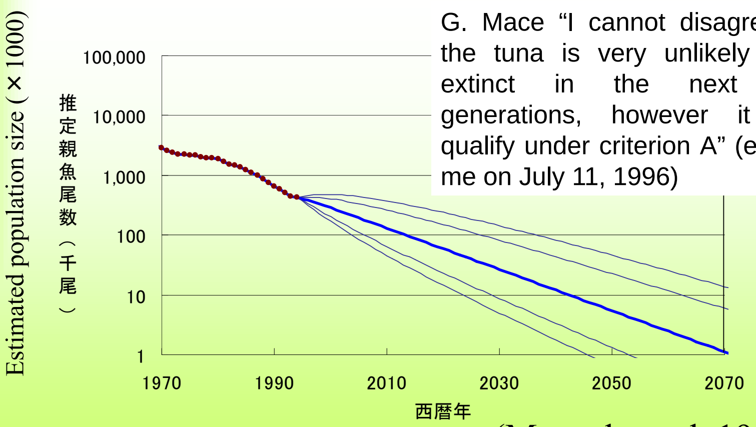
Japan EXPO Assoc. CD-ROM

bluefin tuna (SBT) satisfies Criterion A (80%↓/3



(CCSBT 1998)

ismanagement, SBT will not go extinct wi



G. Mace "I cannot disagree that the tuna is very unlikely to go extinct in the next three generations, however it does qualify under criterion A" (email to me on July 11, 1996)

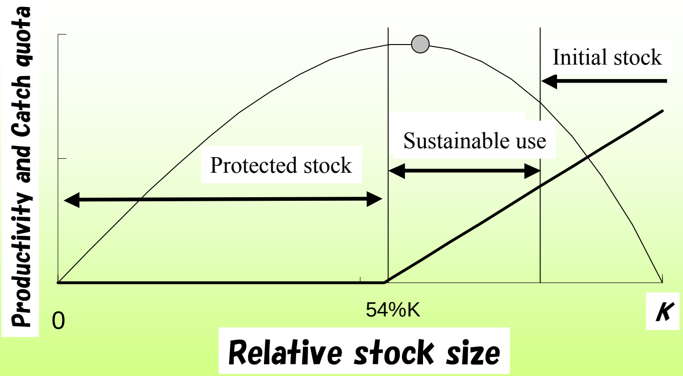
(Matsuda et al. 1996)

G. Mace et al. 1992: *Species* 19:16.

- (The validity of criterion A:) "it can result in the listing of some species with very large, apparently secure populations". (Type-I error)
- "However, linking [the rates of decline] to population size would exclude the listing of many populations with limited census data." (Type-II error)

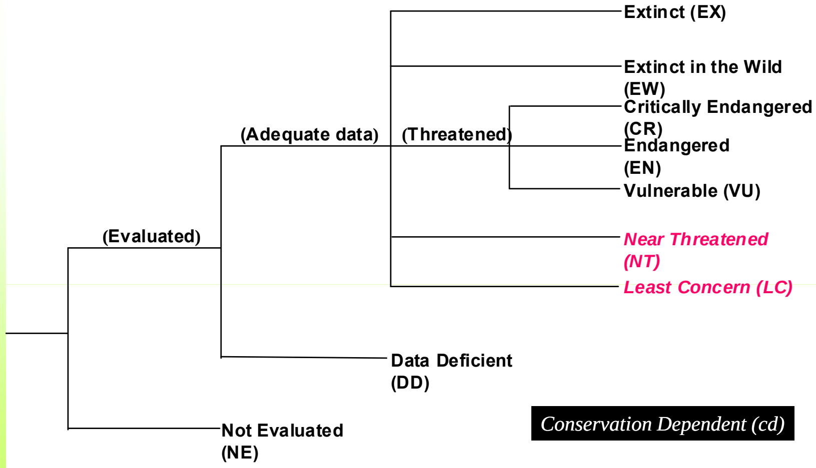
No nations proposed to list SBT in CITES Appendix I.

...gement Procedure in International Whaling



Bayesian approach for measurement uncertainty

IUCN Redlist Categories 2000



A scheme of ecological risks using IUCN Redlist criteria

	CR	EN	VU
A2,3,4 reduction of population	>80%/10yrs or 3 generations	>50%/10yrs or 3 generations	>30%/10yrs or 3 generations
B1 Habitat area	<10km^2	<500km^2	<2000km^2
C1 #population with decreasing	<250(25%/3yrs or 1 generation	<2500(20%/5yrs or 2 generations	<10000(10%/10yrs or 3 generation
D1 Population	<50 matures	<250 matures	<1000 matures
E Extinction risk	50% in 10 yrs or 3 generations	20% in 20 yrs or 5 generations	10% in 100 yrs

[1] http://iucn.org/themes/ssc/siteindx.htm

Red Data Book for Japanese vascular plants (2000)

- Japan has >4000 grids by ca.100 km^2
- Survey of 2000 taxa from 7000 native Japanese vascular plants by 400 taxonomists who can identify all Japanese species. (Threatened taxonomists)
- Ask the population size and decline rate in the past 10 years for each grid.

Matsuda et al. (2002) *Chemosphere* 53: 325-336.

Frequency distribution of population size & reduction rate for each grid

In the case of *Primura sieboldii*

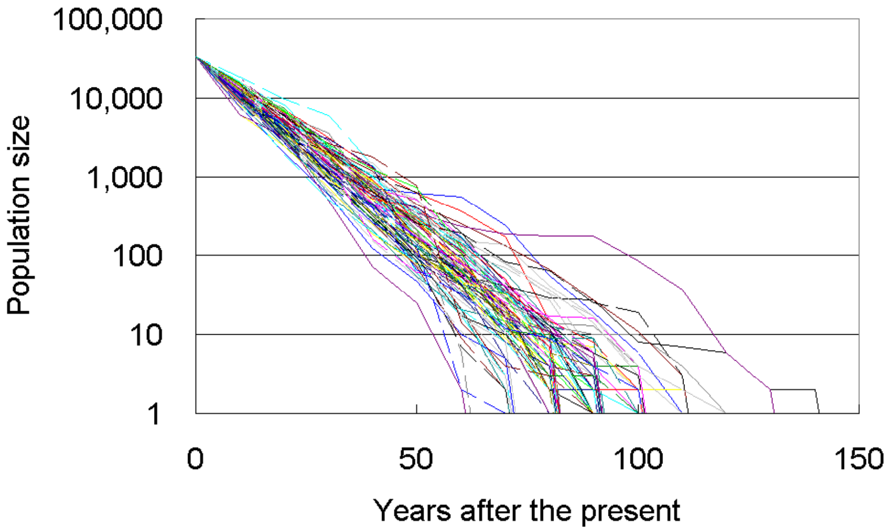
	<0.01	<0.1	<0.5	<1	>1	?	total
>1000		2		1	1	4	8
>100	2	2	1	3	2	5	15
>10	5	16	19	6	2	12	60
>1	1	3	3	2	1	2	12
?			1			22	23
total	8	23	24	12	6	45	118
					extinction		13

$N_p = f_1N_1 + f_2N_2 + f_3N_3 + f_4N_5 = 31977$

Unverified conservative assumptions

- Populations continue to decline by the past 10 yrs rate.
  - Ignore density effect;
  - Ignore regional heterogeneity
  - Use data during the “bubble economy”
  - Ignore increasing conservation effort
- A part of the database is uploaded.

Monte Carlo Simulations to extinction



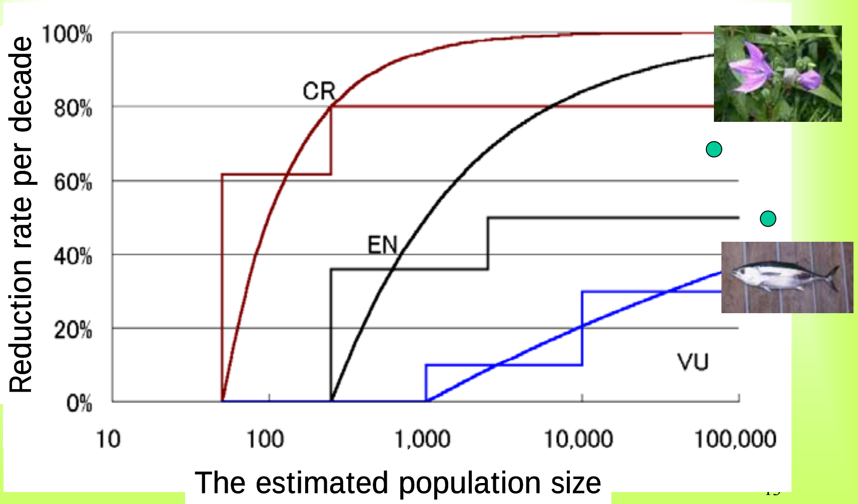
20% of native species are threatened

- Criterion ACD: $N(1-R)^{10}<1000$

or

- Criterion E: $P_{100} > 10\%$,
  then it is listed as Vulnerable (VU)

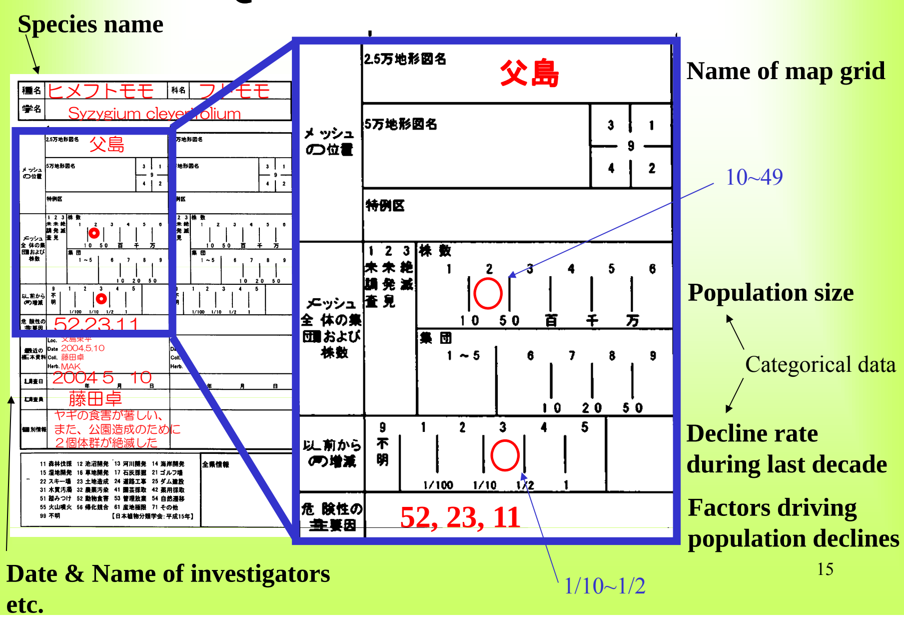
Criteria by IUCN (zigzag) vs Japanese vascular plants (curve)



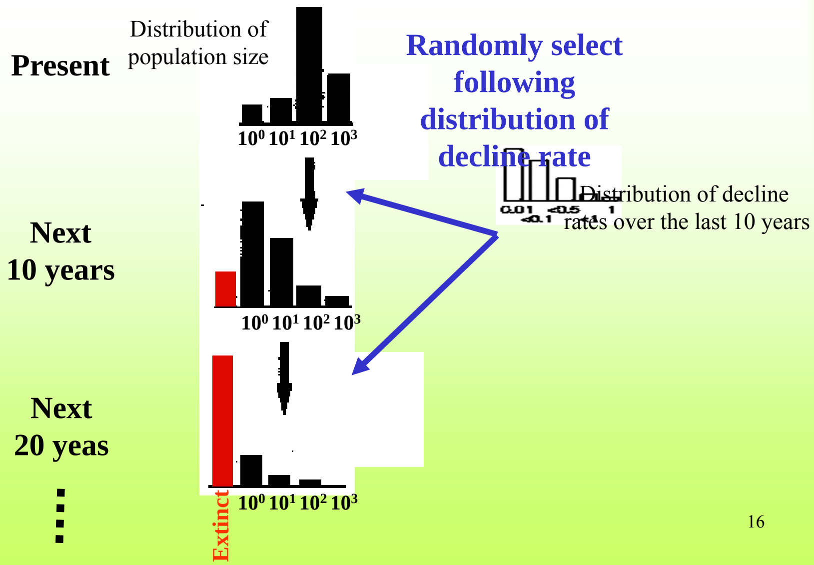
Questionnaire to ca. 400 plant taxonomists, including amateurs

- 4400 maps of ca.100km^2
- ca 400 taxonomists who can identify all 7000 Japanese plants. (such taxonomists are endangered)
- Species list, population size and decline rate of each sp in each map
- Organized by Jpn Soc. Plant Taxon.

Questionnaire items



Extinction risk calculated by Monte Carlo simulation for each species



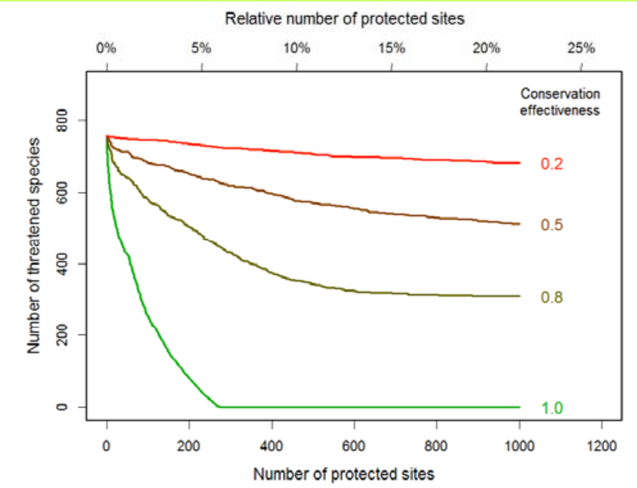


Figure 5 Relationships between number of protected sites and number of species remaining as threatened (probability of extinction in the next 100 years ≥ 10%). Sites are selected to maximize the reduction of extinction risk (see text for details).

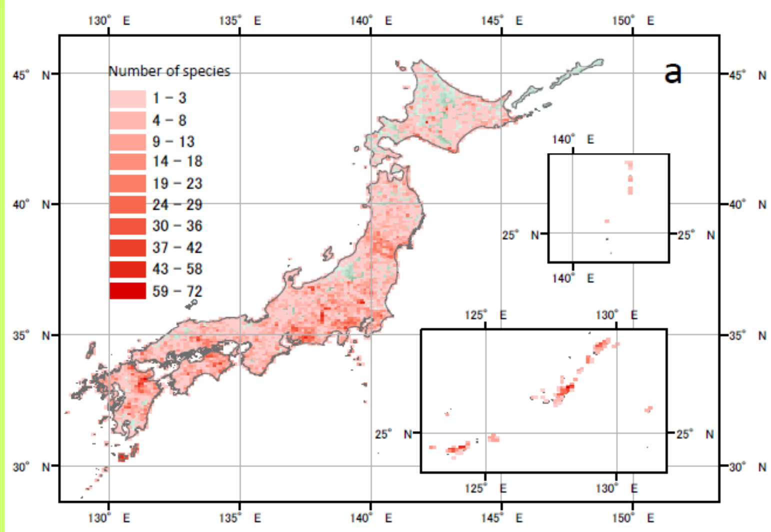
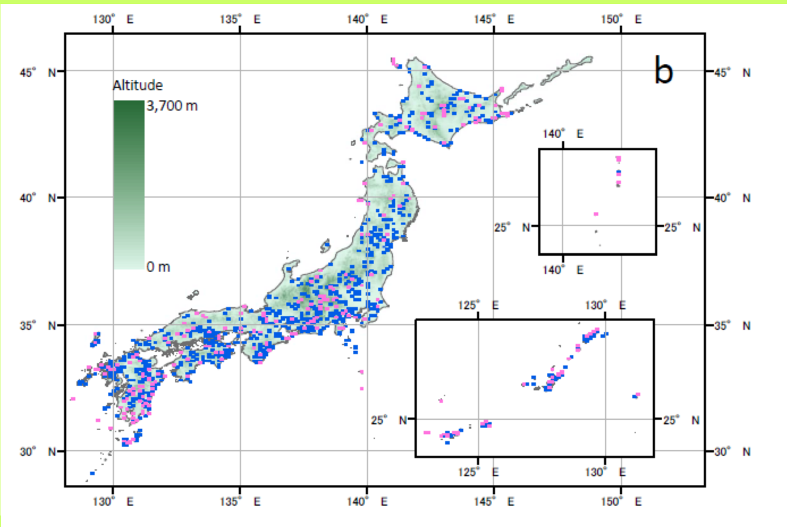
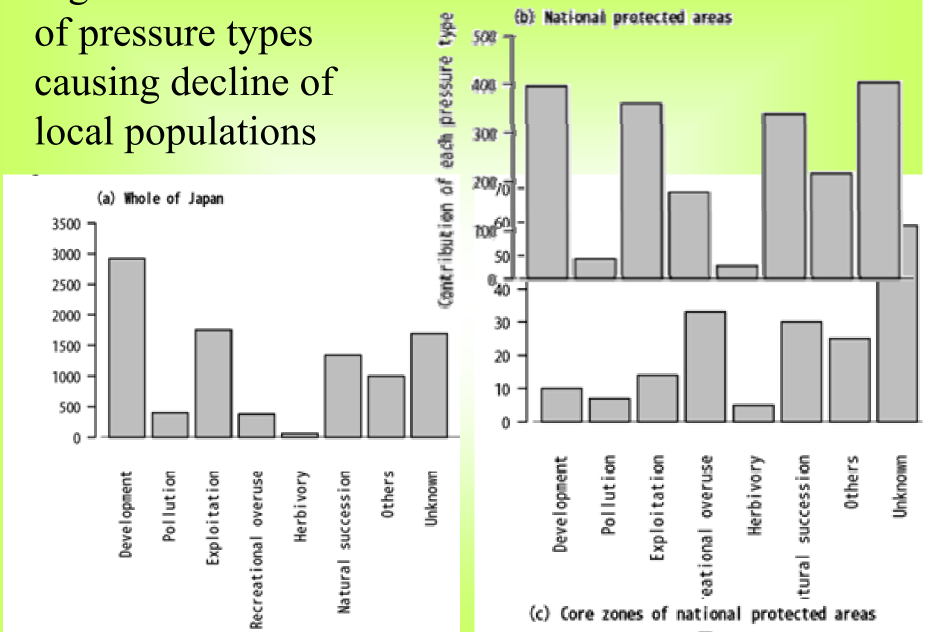


Figure 1 (a) Distribution of 1618 threatened vascular plant species in 4473 terrestrial cells (ca.100 km2) in Japan. One or more species were recorded in 3574 cells (79.9% of Japan).

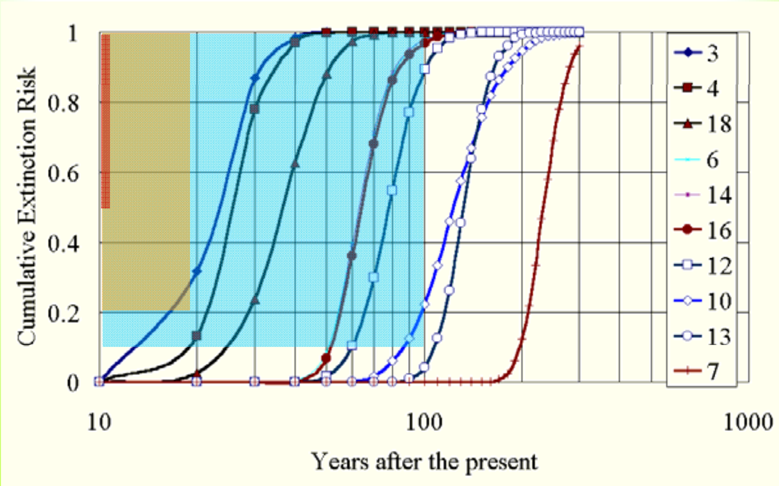


(b) Blue points represent 760 prioritized sites corresponding to 17% of the land area under the assumption that conservation effectiveness is 0.5. Pink points represent 244 cells in which conservation effectiveness needs to be increased to conserve all threatened species; 237 of these are already included in the 760 prioritized cells. ArcGIS 10.1.

Figure 6 Contribution of pressure types causing decline of local populations



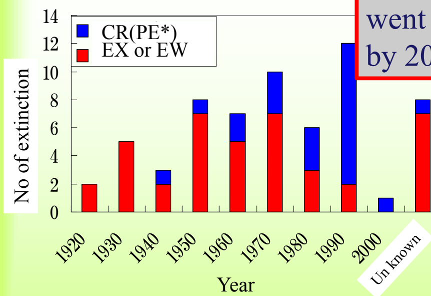
絶滅確率 extinction risk



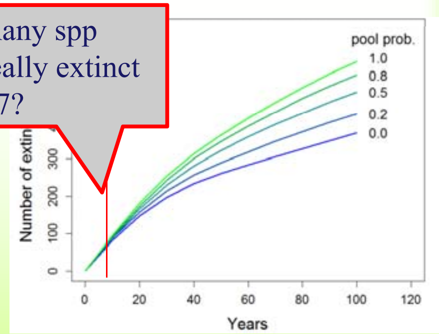
Past & Future Extinction in Japan

Kadoya et al. 2014 PlosOne

Past



How many spp went really extinct by 2007?



Extinction rates (per decade) **8.6 species** → **37-56 species**

4-7 times larger

*PE = Probably extinct (no report of extant grids)

Abuse of precautionary principle..
予防原則誤用

- The extinction risk of a species is often uncertain.
- Threatened species is listed if one of the criteria A-E is satisfied. Therefore,
- it is to be listed solely because of rapid population decline, even though the extinction risk is low.

G. Mace et al. 1992: *Species* 19:16.

- (The validity of criterion A:) "it can result in the listing of some species with very large, apparently secure populations". (Type-I error)
- "However, linking [the rates of decline] to population size would exclude the listing of many populations with limited census data." (Type-II error)


commentary

IUCN's credibility critically endangered

The IUCN is the world's main authority on the conservation status of species, so it is important that its recommendations are based on sound and open science. Recent events suggest that this is not always the case.

N. Mrosovsky

It is heart-warming when a politician as eminent as Norway's former prime minister Gro Harlem Brundtland writes "there is no other basis for sound political decisions than the best available scientific evidence. This is especially true in the fields of resource management and environmental protection"[1]. It is thus particularly sad that the influential World Conservation Union, the International Union for the Conservation of Nature (IUCN), one of whose main aims is to provide data for scientific assessments, is not only failing to do so, but appears to be withholding information.

Although the IUCN and its main subdivision, the Species Survival Commission (SSC), do not have any legally binding authority, their opinions are considered dependable: governments, scientists, journalists and others need a quick, reliable way

Judging a book by its cover: the controversial hawksbill document seen at the CITES meeting.

acknowledged in a letter to the Cuban delegation apologizing for some of these. By then, however, the damage had been done.

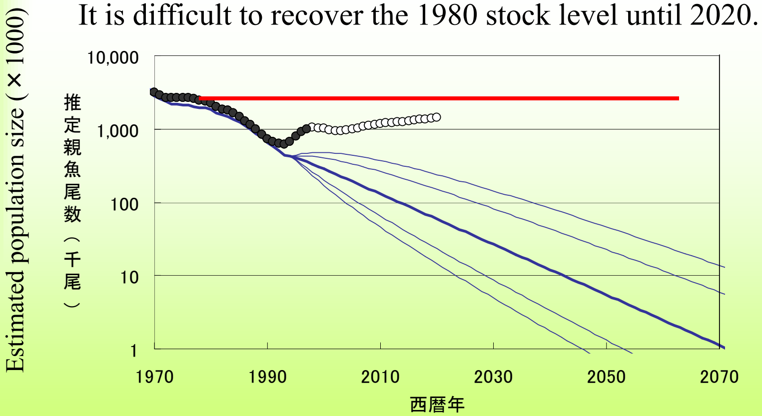
The IUCN makes a distinction between analyses, which do not make recommendations, and position papers, which do. In the case of the hawksbills, no position paper was ever put out. Hence the IUCN is having its cake and eating it: it distributed a document damaging to the Cuban turtle proposal, but it never came out officially against that proposal. The worst feature of the analysis was not that it contained errors, but was the secrecy surrounding some of its sources of data. Many of these are cited in the reference list as "in litt", with a name, meaning that the information is in a letter written to the IUCN by that person. The point of having reference lists is that people can look up the supporting details of statements in the text. But attempts to obtain copies of some of the letters cited in this analysis were unsuccessful. One of the

Allow criterion E to over-rule other criteria !?

- If we do not evaluate extinction risk, nobody disagreed with listing a species by criteria other than Criterion E.
- We disagreed with listing it by criteria A-D if estimated extinction risk is apparently low.
- No consensus was made in IUCN Marine Workshop.
  www.iucn.org/themes/ssc/redlists/marine/marine3.htm
- About 2/3 of IUCN Criteria Workshop participants disagreed with this option.

Will SBT recover?

It is difficult to recover the 1980 stock level until 2020.



(Mori et al. 2001)

Inverse Baby-boom Effect

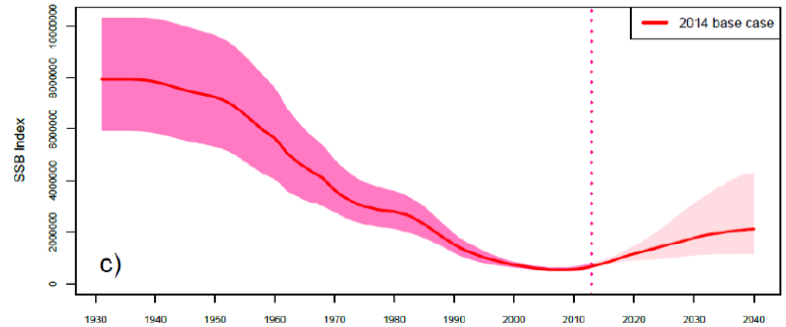


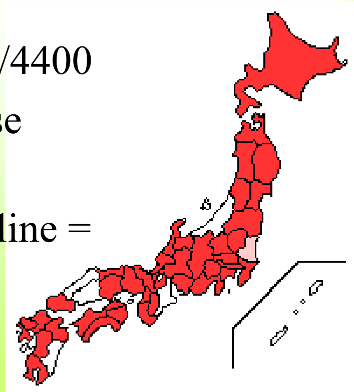
Fig. 1. Base case trajectories for a) recruitment, b) biomass of age 10+ fish, and c) SSB.

The red line with the pink region shows the median and 90% intervals of the current base case. The blue line with the light-blue region shows those for the previous assessment which was calculated in 2011. The dotted line shows the boundaries of the conditioning and projections.

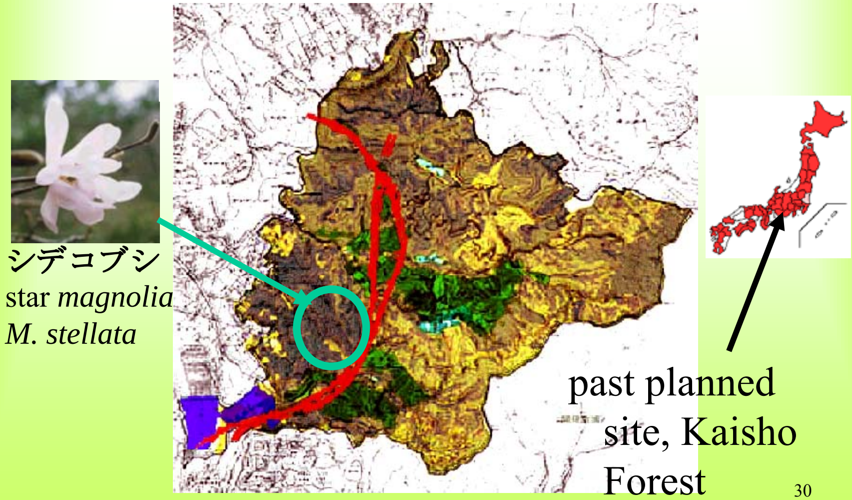
http://www.ccsbt.org/userfiles/file/docs_english/meetings/meeting_reports/ccsbt_21/report_of_SC19.pdf

Bellflower is still widely distributed, but VU

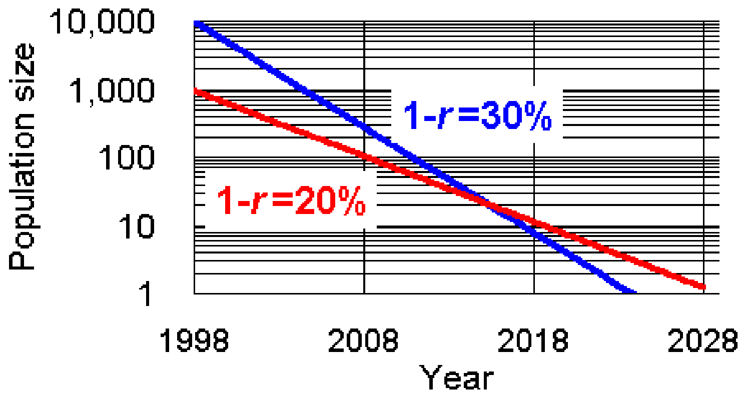
- Population size >20000
- No of extant maps=ca.400/4400
- Rate of population decrease = 70% / 1 decade
- No. of maps where no decline = 6!



2005年日本国際博覧会 World Exposition 2005, Japan

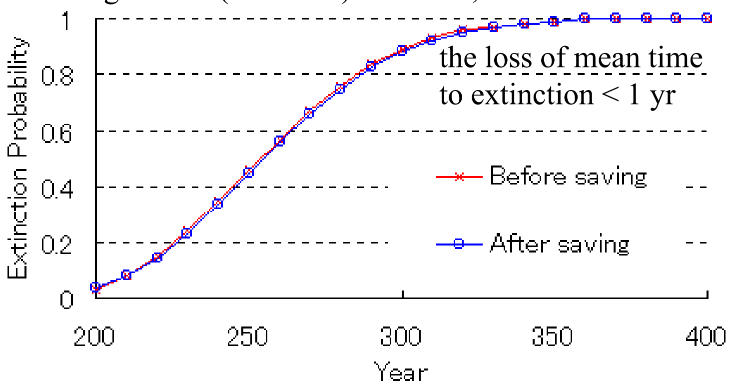


Mean time to extinction = *f* (population size、reduction rate）



Increase of extinction risk of star magnolia by land development in EXPO2005

If a big habitat (400 trees) were lost,



Regressions of *N*, *R* & *T*

- Population size in Japan $N_r = \Sigma n_i \times [3.162 \times 10^i]$
- Reduction rate $R_{reg} = 1 - \Sigma r_i (f_i + p_i)/(1 + \Sigma f_i)$
  - **p**=(0.74, 0.26, 0, 0, 0, 0),
  - **r**=(0.000, 0.000, 0.057, 0.288, 0.751, 1.00)
- Mean time to extinction:

$$T_{reg} = a - b \ln N_r / \ln(1 - R_{reg}) + c \ln(L)$$

a=2.709, b=4.650, c= 4.559

絶滅危惧種への影響の大きさ
impact on threatened species

7: star magnolia
Symbol of Kaisho Forest

12: *Salvia isensis*
シマジタムラソウ

Sp.	RDB	R	N_1	N_2	N_p	N_g	T_0	$\Delta(1/T)$	$\Delta \log T$
12	VU	0.59	4370	447	>1000	10	84	5×10^{-5}	0.004
13	VU	0.46	137	31	1000	40	128	2×10^{-6}	3×10^{-4}
19	VU	0.68	1721	108	7000	20	77	2×10^{-6}	2×10^{-4}
4	EN	0.84	31	18	2000	20	38	3×10^{-6}	1×10^{-4}
7	**VU**	**0.29**	**1554**	**140**	**10000**	**20**	**302**	3×10^{-7}	9×10^{-5}
25	nt	0.35	1888	681	100000	60	274	2×10^{-7}	4×10^{-5}
3	EN	0.85	13	9	4000	10	40	7×10^{-7}	3×10^{-5}
26	nt	0.48	64	41	10000	50	156	1×10^{-7}	2×10^{-5}
23	nt	0.38	711	88	30000	60	229	9×10^{-8}	2×10^{-5}
5	EN	0.74	2	1	2000	20	56	9×10^{-8}	5×10^{-6}
20	VU	0.62	2	1	3000	100	88	3×10^{-8}	3×10^{-6}
24	nt	0.31	127	33	60000	50	316	1×10^{-8}	4×10^{-6}

The impact on *Salvia isensis* is bigger than the impact on star magnolia

- Before nomination in 1996, the site plan was changed for conservation of a big habitat of star magnolia
- Environ. Impact Assessment showed a bigger impact.
- Aichi Prefecture first ignored the latter in 1999;
- After BIE's criticism, the site plan was thoroughly changed.

Salvia isensis
シマジタムラソウ

中池見液化天然ガス基地
LNG plant project in Nakaikemi wetland

- 希少種の宝庫にLNG基地計画
  - LNG plant in hotspot of rare species
- 放置しても失われる二次的自然
  - the secondary natural life that has been occationally main-tained by rice fiel

2つの極端な前提
2 extreme premises

- 事業者努力で維持
  - Maintained by company's effort
  - Biodiversity will be lost due to natural succession in abandoned rice field
- 事業によって消失
  - Lost by LNG plant construction

多様性損失指数
Expected loss of biodiversity

- ELB = $B\,\Delta(1/T)$

  ＝生物多様性貢献度

  ×絶滅リスク上昇

  Contribution of biodiversity

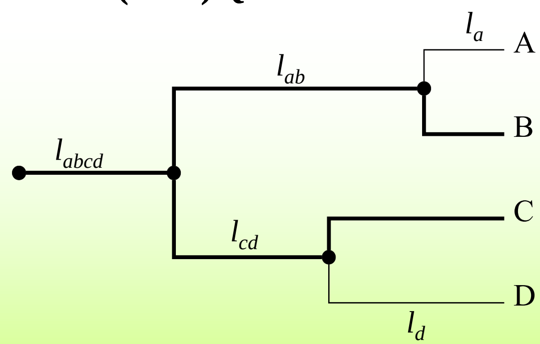
  ×increment of extinction risk

多様性貢献度＝系統樹の損失
B=loss of phylogenic tree

- 4億年前に維管束植物出現
  - vascular plants appeared 400million years ago
- ΣELB=9200 years
  - 9200年の歴史の喪失
  - loss of 9200yrs history

How long linage is lost by extinction?
系統樹の長さによる多様度

Weitzman ML(1992) *Quart.J.Econ.*107:363-406.



- **Importance of phylogenically isolated species (l_d>l_a)**

eny of fern plants (Hasebe et al 1995 Am Fern J)

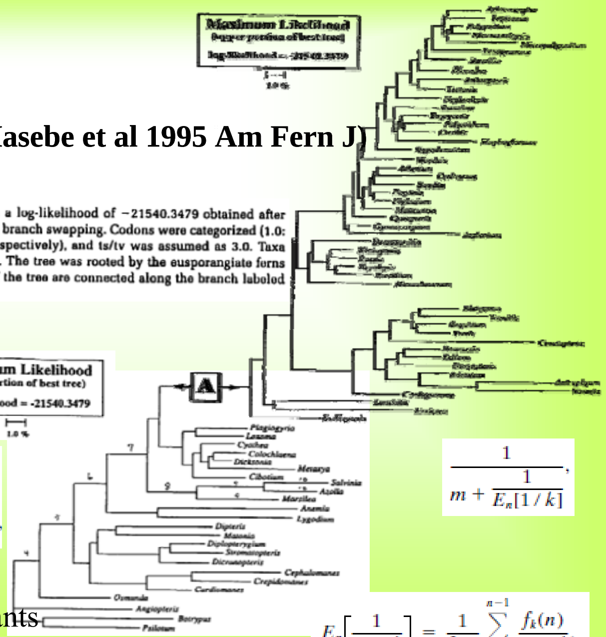


FIG. 5. The best maximum likelihood tree with a log-likelihood of −21540.3479 obtained after 30 random sequence addition searches with local branch swapping. Codons were categorized (1.0: 0.39:8.0 for first:secong:third codon positions, respectively), and ts/tv was assumed as 3.0. Taxa shown in the tree are indicated in the Appendix. The tree was rooted by the eusporangiate ferns and Psilotaceae. The basal and upper portions of the tree are connected along the branch labeled "A".

$$f(n) = \sum_{i=1}^{n-1} f_i(n).$$

$$f_1(n) = f(n-1)$$

$$f_k(n) = \sum_{i=1}^{n-k} {}_{n-1}C_i f(i) f_{k-1}(n-i),$$

$$\frac{1}{m + \frac{1}{E_n[1/k]}},$$

$$E_n\left[\frac{1}{m+k}\right] = \frac{1}{f(n)} \sum_{k=1}^{n-1} \frac{f_k(n)}{m+k},$$

Phylogeny of seed plants
(Chase et al. 1993)

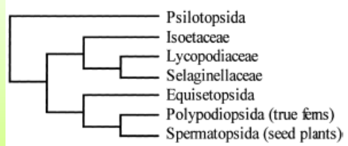
Mathematical approximation

$f_k(n)$: The number of phylogenetic trees in which a species A has k nodes between itself and the root of the upper taxons when there are n species within the taxon.

E[1/(m+k)]: the expected value of the reciprocal of the number of nodes between the terminal node for species A and the root of the whole node

$$f_1(n) = f(n-1) \qquad f(n) = \sum_{i=1}^{n-1} f_i(n).$$

$$f_k(n) = \sum_{i=1}^{n-k} {}_{n-1}C_i f(i) f_{k-1}(n-i),$$



$$E_n\left[\frac{1}{m+k}\right] = \frac{1}{f(n)} \sum_{k=1}^{n-1} \frac{f_k(n)}{m+k}, = \frac{1}{m + \frac{1}{E_n[1/k]}},$$

loss of 9200 years of evo-history

(Oka, Matsuda, Kadono 2001 Risk Anal. 21)

Ecological Risk–Benefit Analysis of a Wetland Development Based on Risk Assessment Using "Expected Loss of Biodiversity"

Species name	rank	ΔN	log$N$	N_g	1-R	T	logΔ(1/T)	log$B$	ELB
Eusteralis yatabeana	VU	>100	3.7	17	76%	36	−3.45	6.5	1214
Najas japonica	EN	?	3.3	29	80%	38	−3.81	7.1	1782
Trapa i nci sa	VU	>1000	3.6	50	55%	85	−3.85	7.1	1755
Monochoria korsakowii	VU	>1000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sparganium japoinica	NT	<10	4.4	114	34%	202	−4.96	7.1	139
Isoetes japonica	VU	>100	4.4	149	58%	90	−5.05	7.5	261
Iris laevigata	VU	>100	4.4	81	54%	102	−5.20	6.8	40
Salvinia natans	VU	>100	4.7	104	77%	55	−5.24	7.5	161
Sagittaria aginashi	NT	>100	4.8	128	40%	162	−5.36	7.0	49
Sparganium erectum	NT	>100	4.6	148	38%	185	−5.72	7.1	24
Habenaria sagittifera	VU	>100	4.1	121	61%	82	−5.83	6.3	3

ΔN	log$N$	N_g	1-R	T	logΔ(1/T)	log$B$	ELB
>100	3.7	17	76%	36	−3.45	6.5	1214

福井港建設案 との経済的比較

Economical benefit (v. Fukui Port plan)

- To need 75km longer pipelines;
  長いパイプラインと
- additional dredge the port
  – 福井港のさらなる浚渫が必要

=+91-100 billion yen(1000億円)

=4 billion yen/yr　年40億円

保全エリアの維持コスト
cost for conservation area

- 初期投資に10億円
  - 1 billion yen for initial investment
- 維持費が年6000万円
  - 60 million yen/yr for running cost

＝120 million yen/yr