2.1

2 1

1958~1993 20 1994

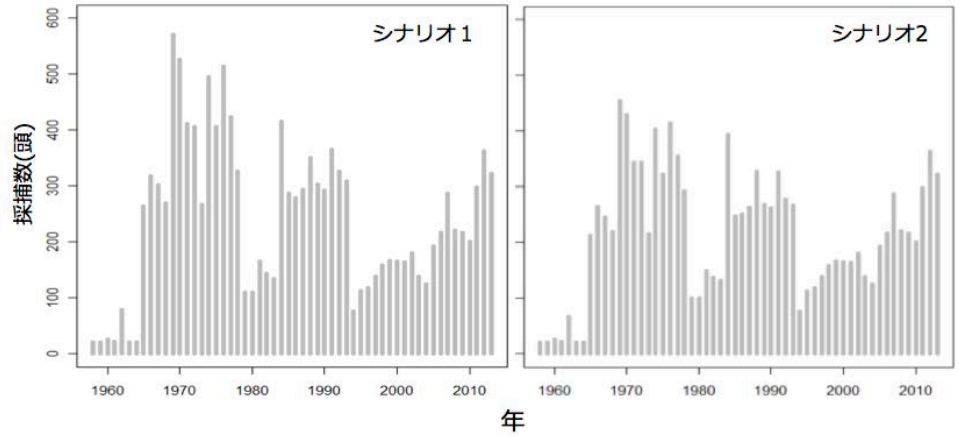
1.3 1958

: 8

:

1957

1958



1. 1

2.2

2005 2009 1 2010 2014 2 2014

1 3

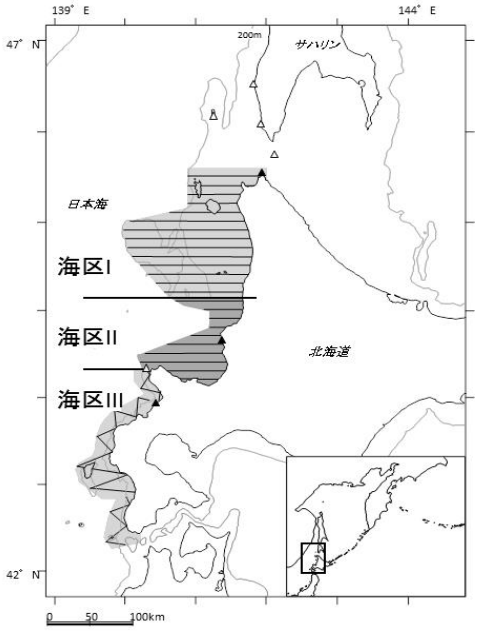
5 2 4

1 2

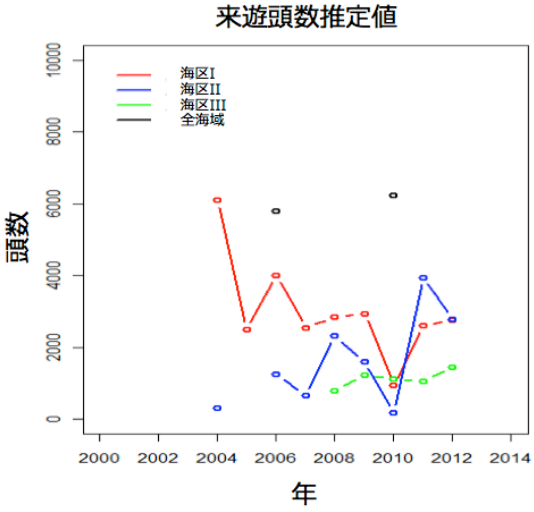
3 5

11

1 2005 2004



2.



3. (
)

3.1

2

$$N_{t+1} = N_t + rN_t\left(1-\left(\frac{N_t}{K}\right)^z\right) - C_t$$

N_t t C_t t r K

3 4 (Z

z=1) t $\hat{N}_t$ 5

$$\log \hat{N}_t \sim N(\log N_t, \tau^2 + cv_t^2)$$

τ^2 cv_t 6

r, K, τ^2 1958

$D_{1958} = N_{1958} / K$ 4 r, K, D_{1958}, τ^2

2

(τ^2 =0)

r=0.12 *r*=0.10, 0.12, 0.14 *K* D_{1958} [7]

$$\log L(K, D_{1958}) = -\frac{1}{2}\sum_t \log\left[2\pi cv_t^2\right] - \sum_t \frac{(\log \hat{N}_t - \log N_t)^2}{2\,cv_t^2} \Rightarrow \max$$

3.2 10

(1958~2013)

10 2024 50,60,70,80

10

3.3

4

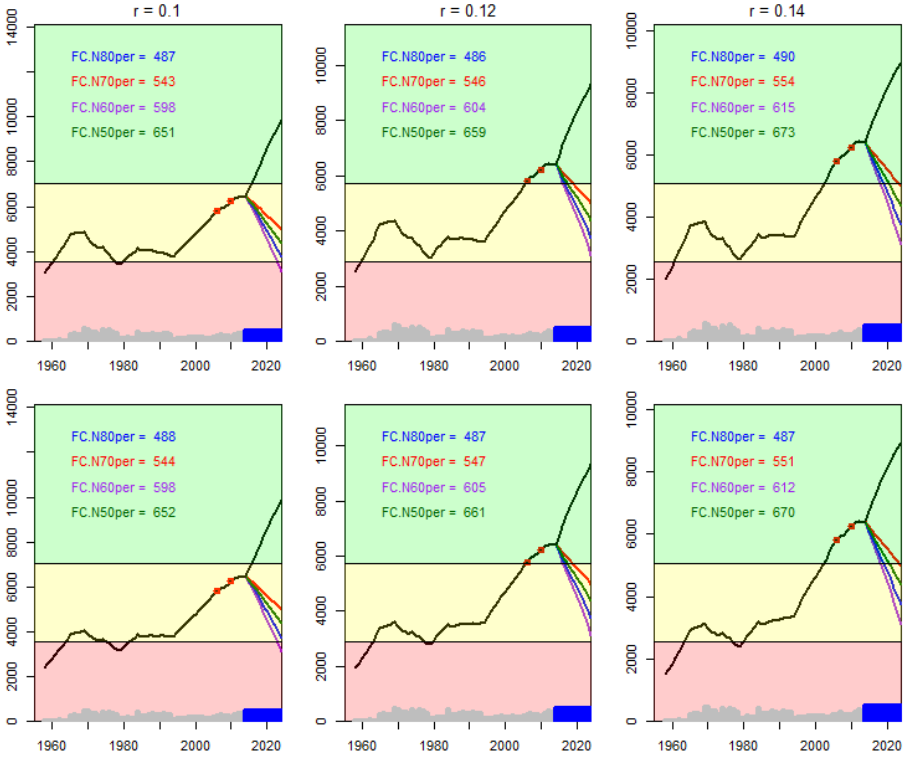
r=0.10, 0.12, 0.14

1958 20%

50

10 50~80%

4



4.

r *r*=0.10, 0.12, 0.14

10 XX (XX=50 80)

0 25 25 50 50 100

4.

2014

8

:

$$N_{t+1} = \left[N_t + rN_t \left(1 - \left(\frac{N_t}{K} \right)^z \right) - C_t \right] \exp(u_t)$$

$$u_t \sim N(-0.5\sigma^2, \sigma^2)$$

σ

σ =0.04 0.08

11 5

(=0.15) 11

PBR 1

30 (HCRs) HCR5 HCR8 10 60

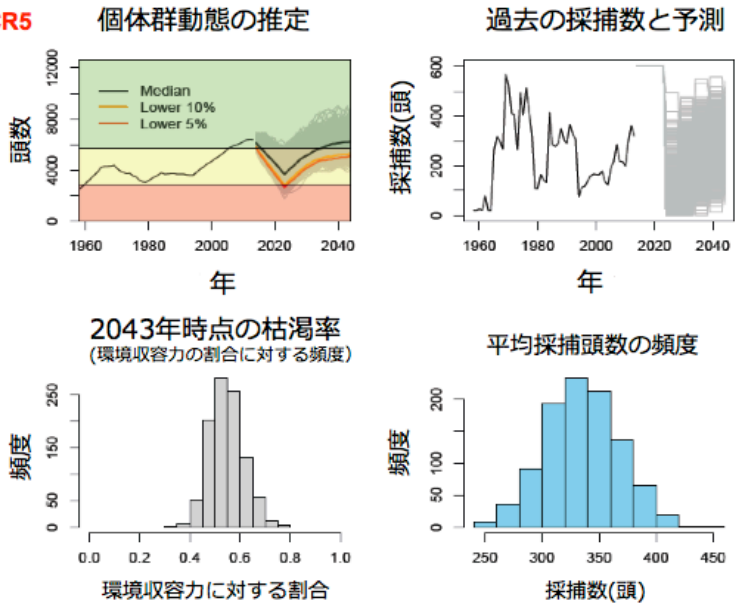
50

1000

30 HCR

HCR		
1	0	
2	PBR=0.5*r_{max}*$N_{t,min}$*FR (2014~2043)	FR=0.5, r_{max}=0.12
3	PBR=0.5*r_{max}*$N_{t,min}$*FR (2014~2043)	FR=1.0, r_{max}=0.12
4	C=FC.N50%=659 (2014~2023) PBR=0.5*r_{max}*$N_{t,min}$*FR (2024~2043)	2024 (H36) 50% PBR FR 1.0
5	C=FC.N60%=604 (2014~2023) PBR=0.5*r_{max}*$N_{t,min}$*FR (2024~2043)	2024 (H36) 60% PBR FR 1.0
6	C=FC.N70%=546 (2014~2023) PBR=0.5*r_{max}*$N_{t,min}$*FR (2024~2043)	2024 (H36) 70% PBR FR 1.0
7	C=FC.N50%=659 (2014~2023) PBR=0.5*r_{max}*$N_{t,min}$*1 (N_t/K ≧ 0.5) PBR=0.5*r_{max}*$N_{t,min}$*FR_t (0.25<N_t/K ≦ 0.5) (2024~2043) PBR=0 (N_t/K < 0.25)	2024 (H36) 50% PBR FR FR_t = 4*(N_t/K-0.25)
8	C=FC.N60%=604 (2014~2023) PBR=0.5*r_{max}*$N_{t,min}$*1 (N_t/K ≧ 0.5) PBR=0.5*r_{max}*$N_{t,min}$*FR_t (0.25<N_t/K ≦ 0.5) (2024~2043) PBR=0 (N_t/K < 0.25)	2024 (H36) 60% PBR FR FR_t = 4*(N_t/K-0.25)
9	C=FC.N70%=546 (2014~2023) PBR=0.5*r_{max}*$N_{t,min}$*1 (N_t/K 0.5) PBR=0.5*r_{max}*$N_{t,min}$*FR_t (0.25<N_t/K 0.5) (2024~2043) PBR=0 (N_t/K < 0.25)	2024 (H36) 70% PBR FR FR_t = 4*(N_t/K-0.25)

図5.1 σ=0.04, HCR5



5. (σ=0.04 0.08) HCR5 8 ( )
( ) 30 ( ) 30 .
10 5

図5.2 σ=0.04, HCR8

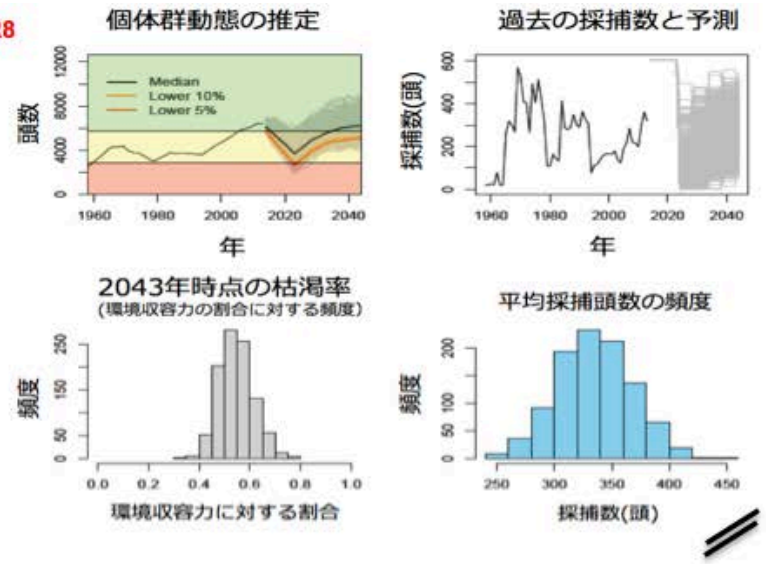


図5.3 σ=0.08, HCR5

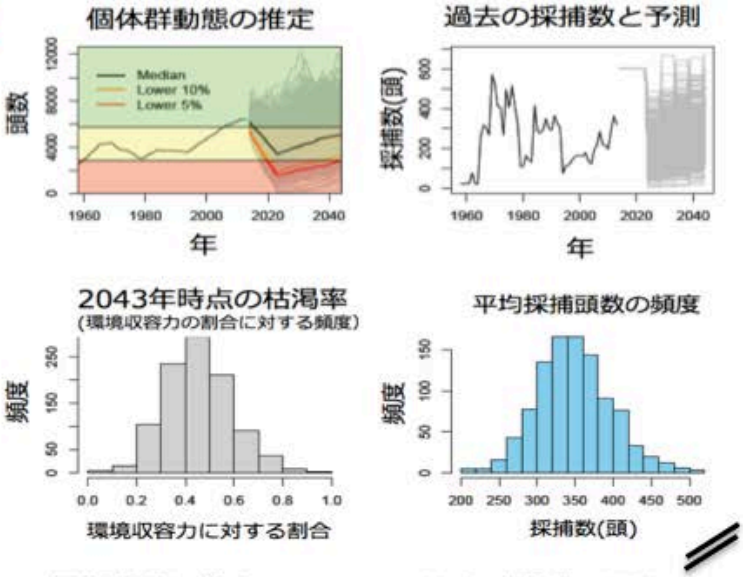
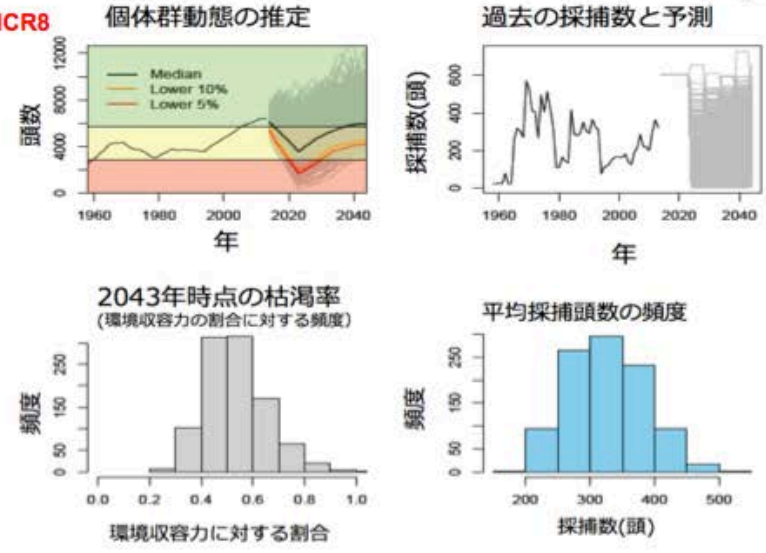
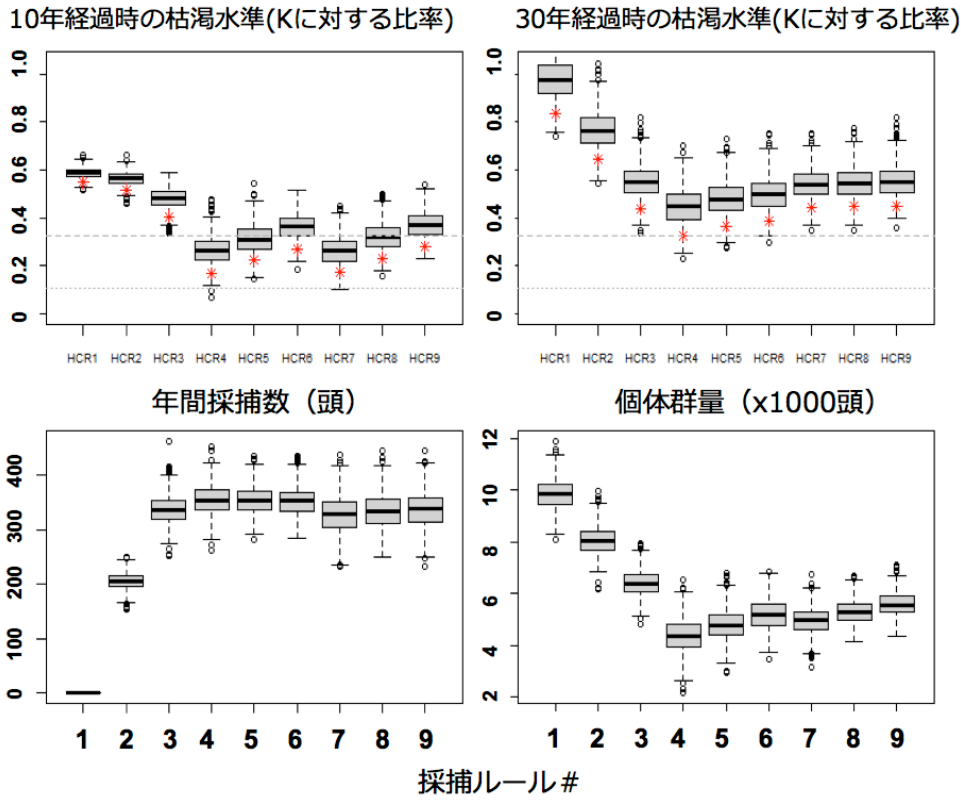


図5.4 σ=0.08, HCR8

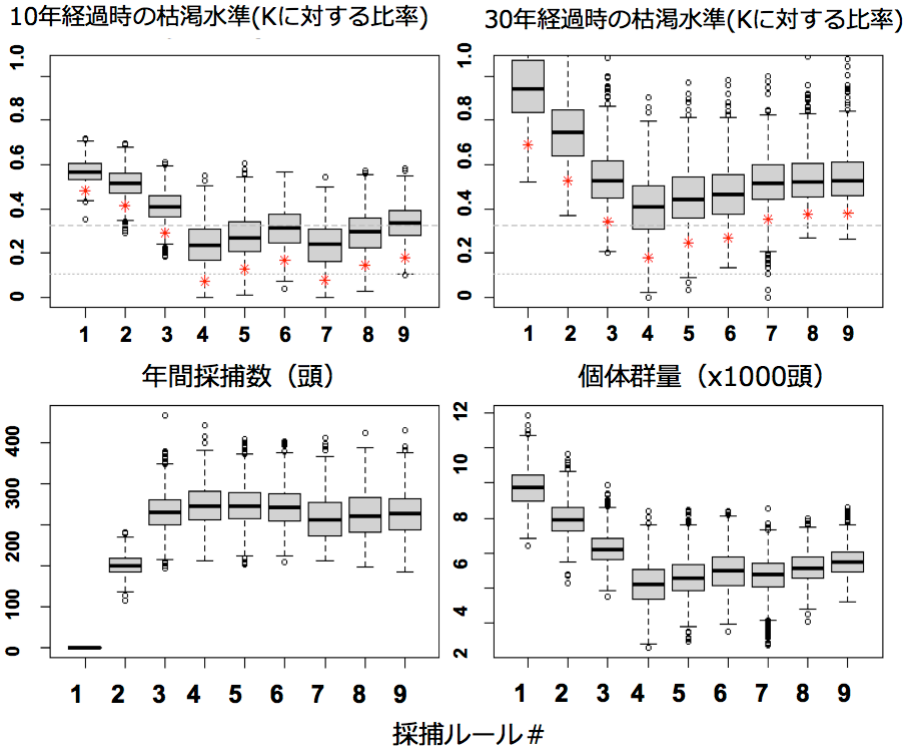


5 .

(A) σ=0.04



(B) σ=0.08



6 5%

60% (32.6%) 20% (10.9%)

5 HCR5 HCR8 30
11 PBR

6 10 30
10 60% (32.6%)
30 5% 20% (10.9%)
(1) 30 20
5 100
PBR
100 30
(2) 100 10
8

5

10
11

5 10

11 PBR

σ=0.04
σ=0.08
σ=0.04
σ
2
× 5 5
15

10 604 11 PBR
( ) IV
5

1 *PBR* (Potential Biological Removal)

(Marine mammal protection act)

K/2

PBR=0.5 x

N_{min} x R_{max} x F_R N_{min}, R_{max}, F_R (

) 3

0.1

1.0

2

.

K **4**

3

4

5

.

6

7

8