Evaluation of the Impacts of Seedlings on Abalone Reproduction by Genetic Approach

Motoyuki Hara*, Hiroshi Hoshikawa, Toyomitsu Horii*** 호리이

* Fisheries Research Agency
** Hokkaido Central Fisheries Experiment Station

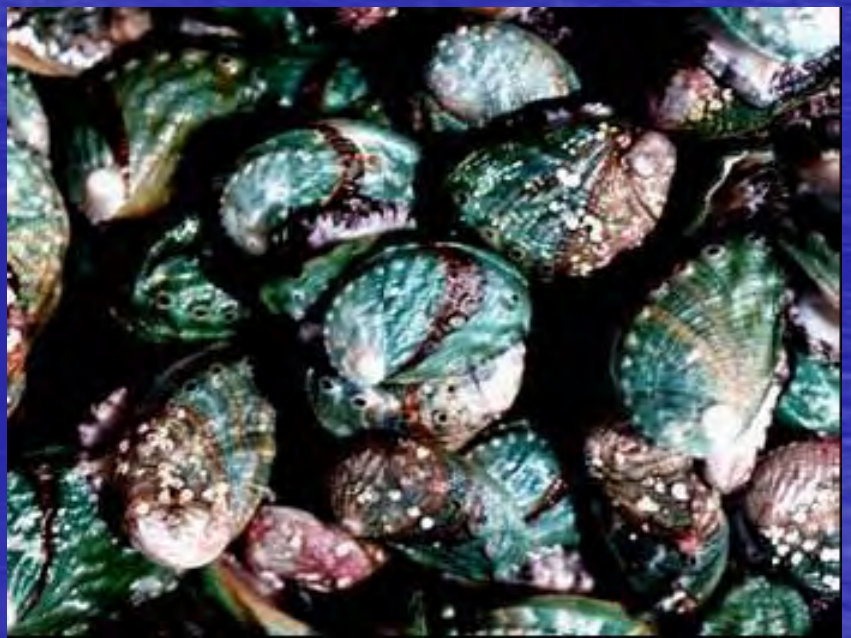


Table of Contents

Commercial species in Japan

Large

Haliotis discus hannai

H. discus discus

Large

H. gigantea

Large

H. madaka

H. diversicolor aquatilis

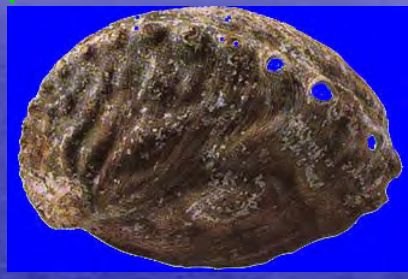
Small

H. diversicolor diversicolor

Habitat distribution of large abalone in Japan

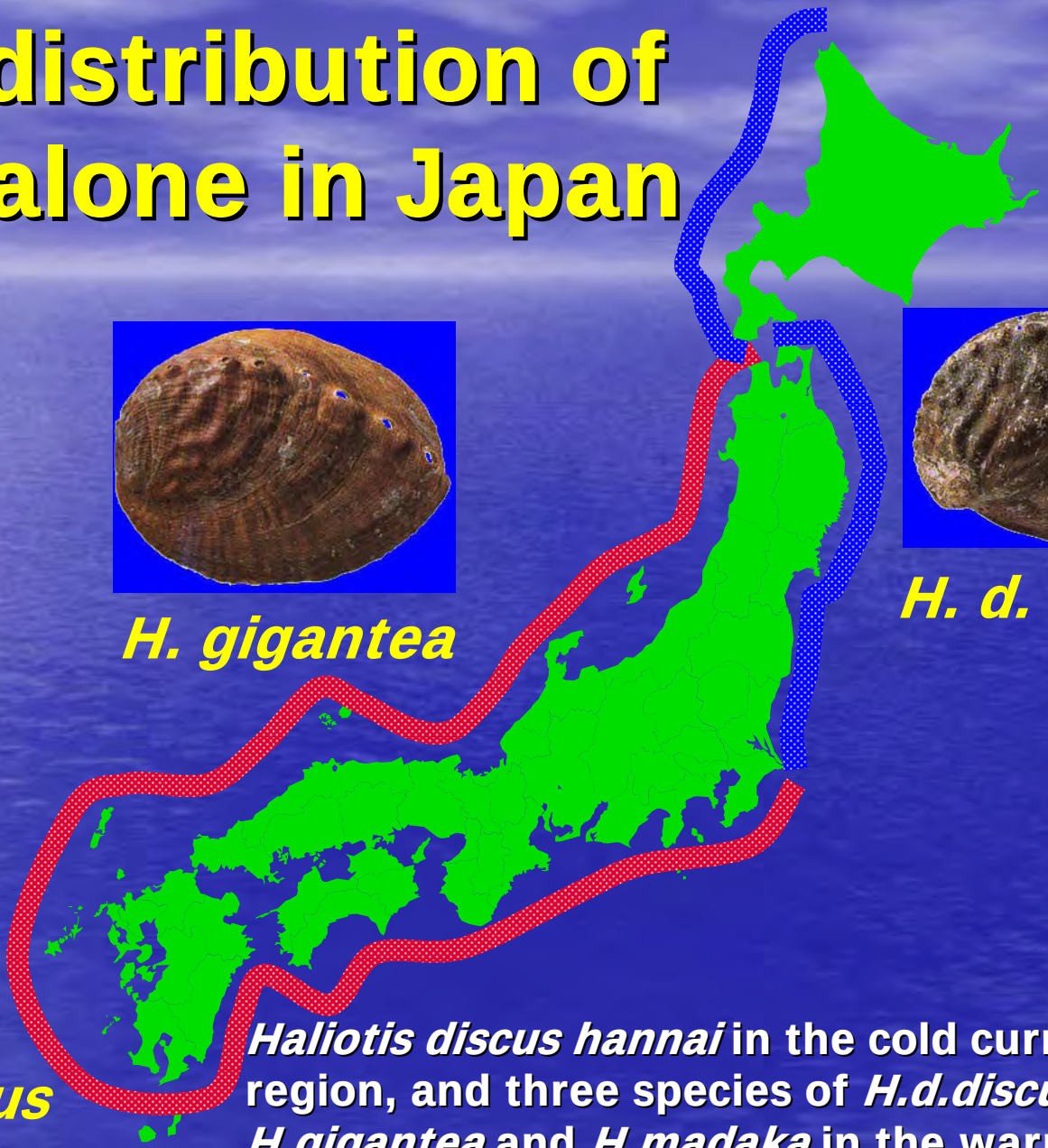
H. madaka

H. gigantea

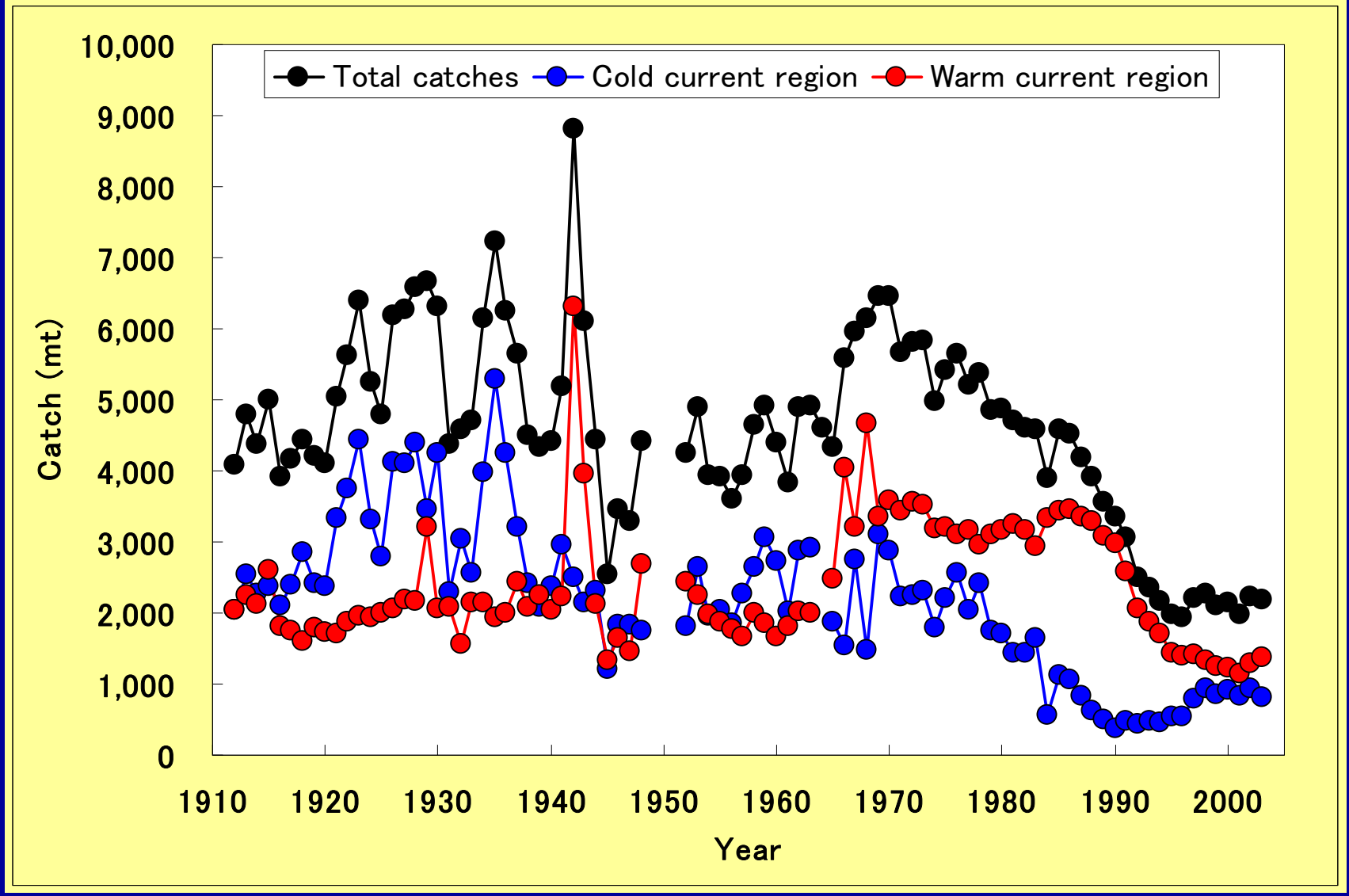


H. d. hannai

H. discus discus



Haliotis discus hannai **in the cold current region, and three species of** ***H.d.discus,*** ***H.gigantea*** **and** ***H.madaka*** **in the warm region.**



Trends of abalone catches in Japan

The catches in cold current region was stable from 1910 to 1970, and declined rapidly afterwards. On the other hands, that in warm current region declined since 90s.

Fishery Management System on Abalone in Japan

Fishery rights on coastal and sedentary resources
(abalone, clam, sea urchin, kelp etc.)

5,000 areas around the coast of Japan

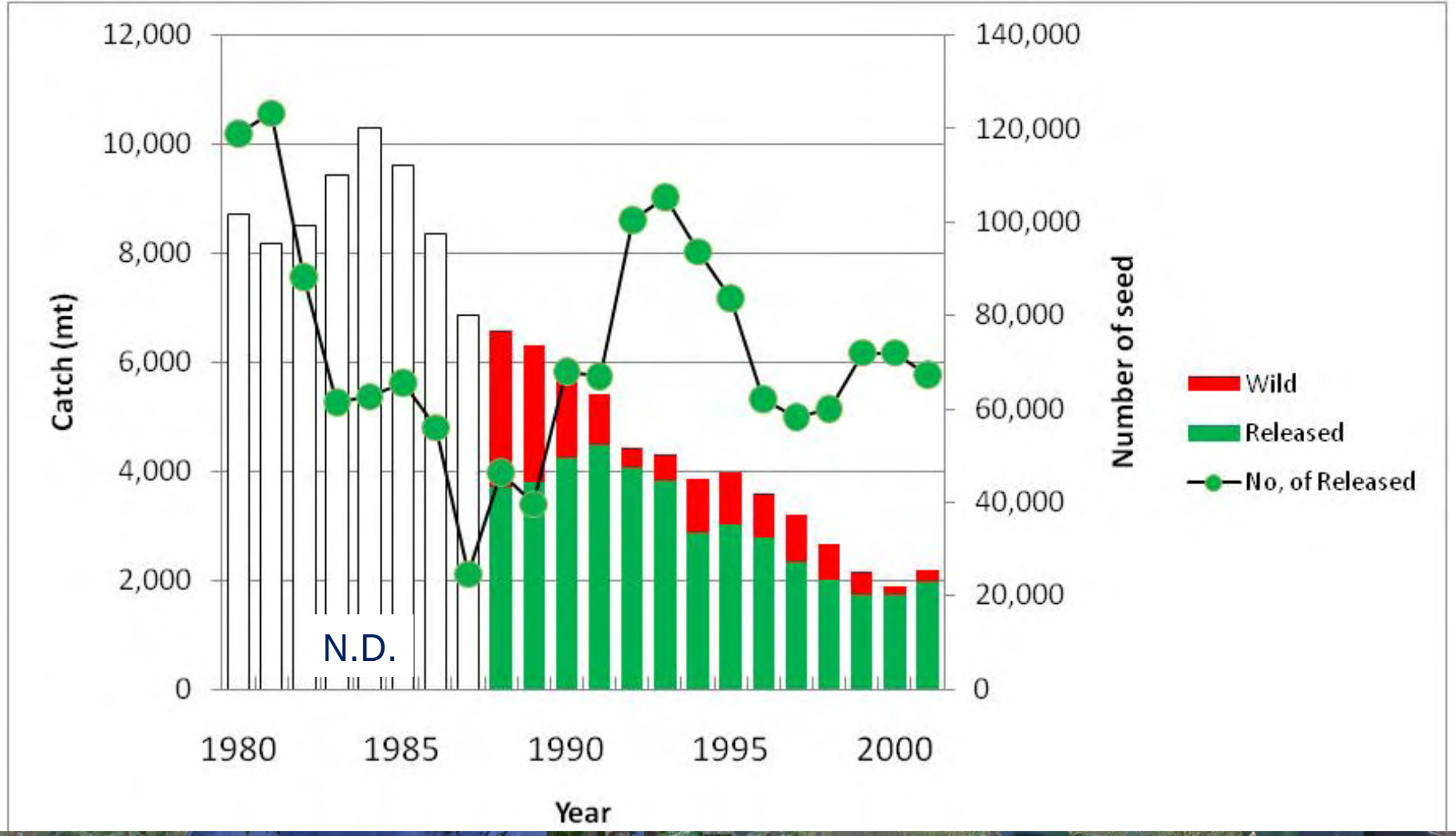
- Law of Fisheries (Basic Law)
  established by government
- Rule of fisheries regulation
  by local government (prefecture)
- Rule of exercising fisheries right
  by fisheries cooperative association

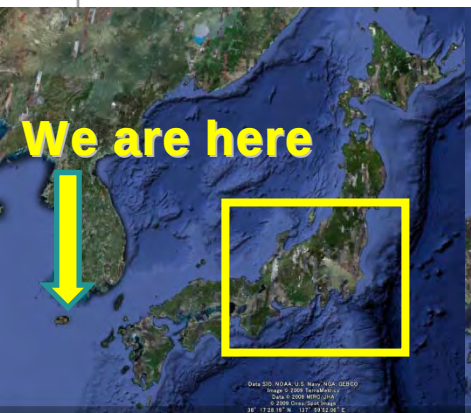
Why has the abalone population been declined?

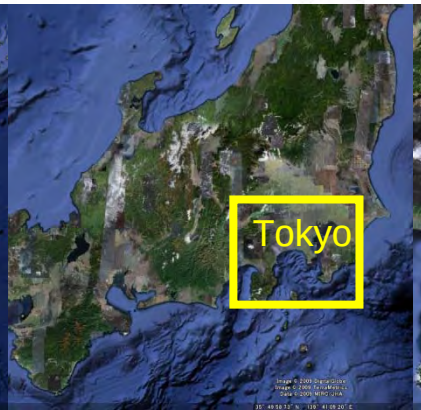
- **Over-fishing & poaching**
- **Climate change**

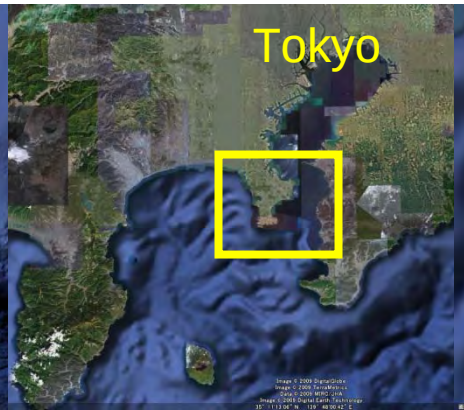
Why has the abalone population been declined in spite of seedlings?

- **Too short number of seeds?**
- **Low survive of seeds?**
- **Low re-productivity of seeds?**

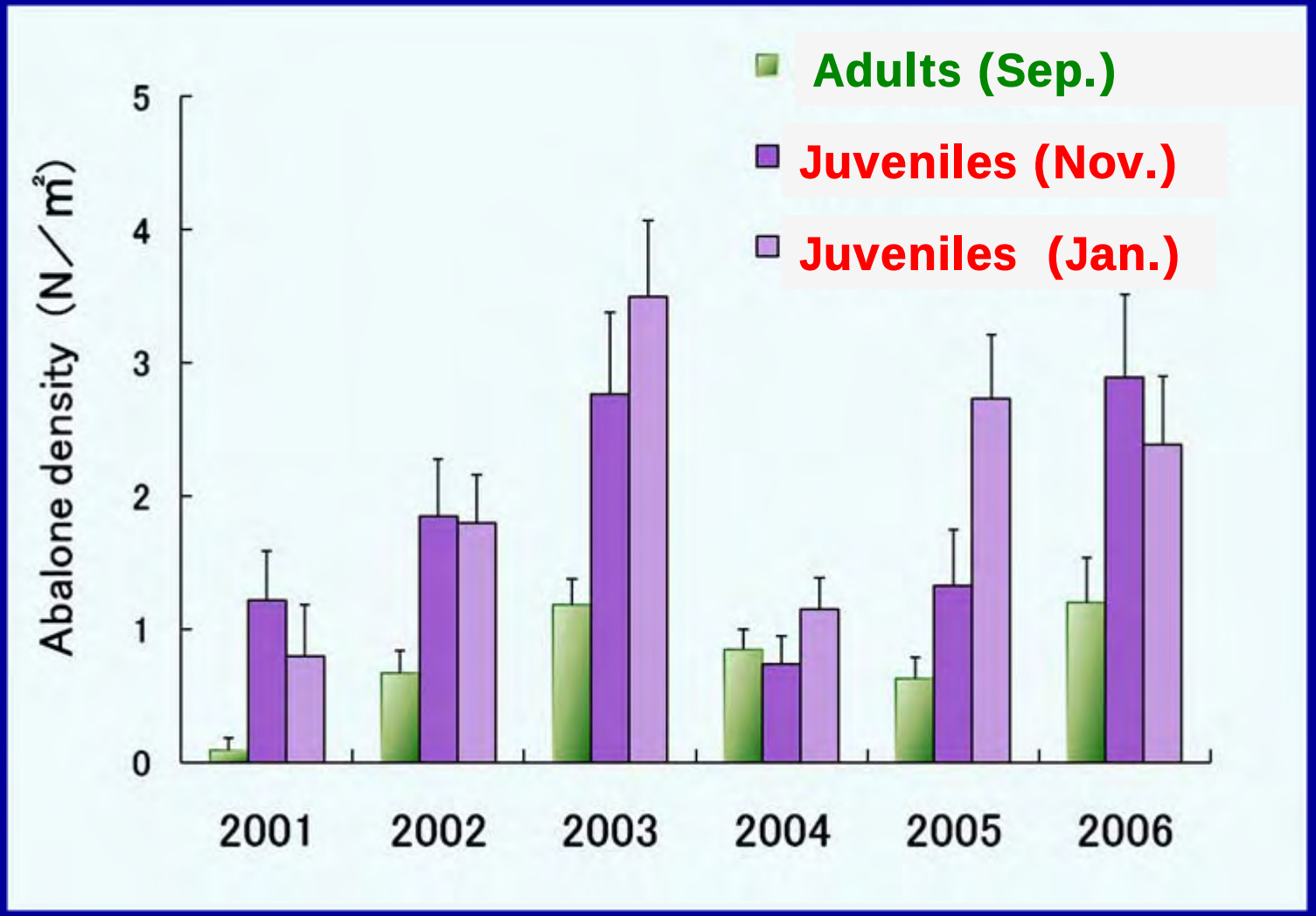

12,000
10,000
8,000
6,000
4,000
2,000
0
Catch (mt)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Number of seed
N.D.
1980
1985
1990
1995
2000
Year
Wild
Released
No, of Released


We are here


Tokyo


Tokyo

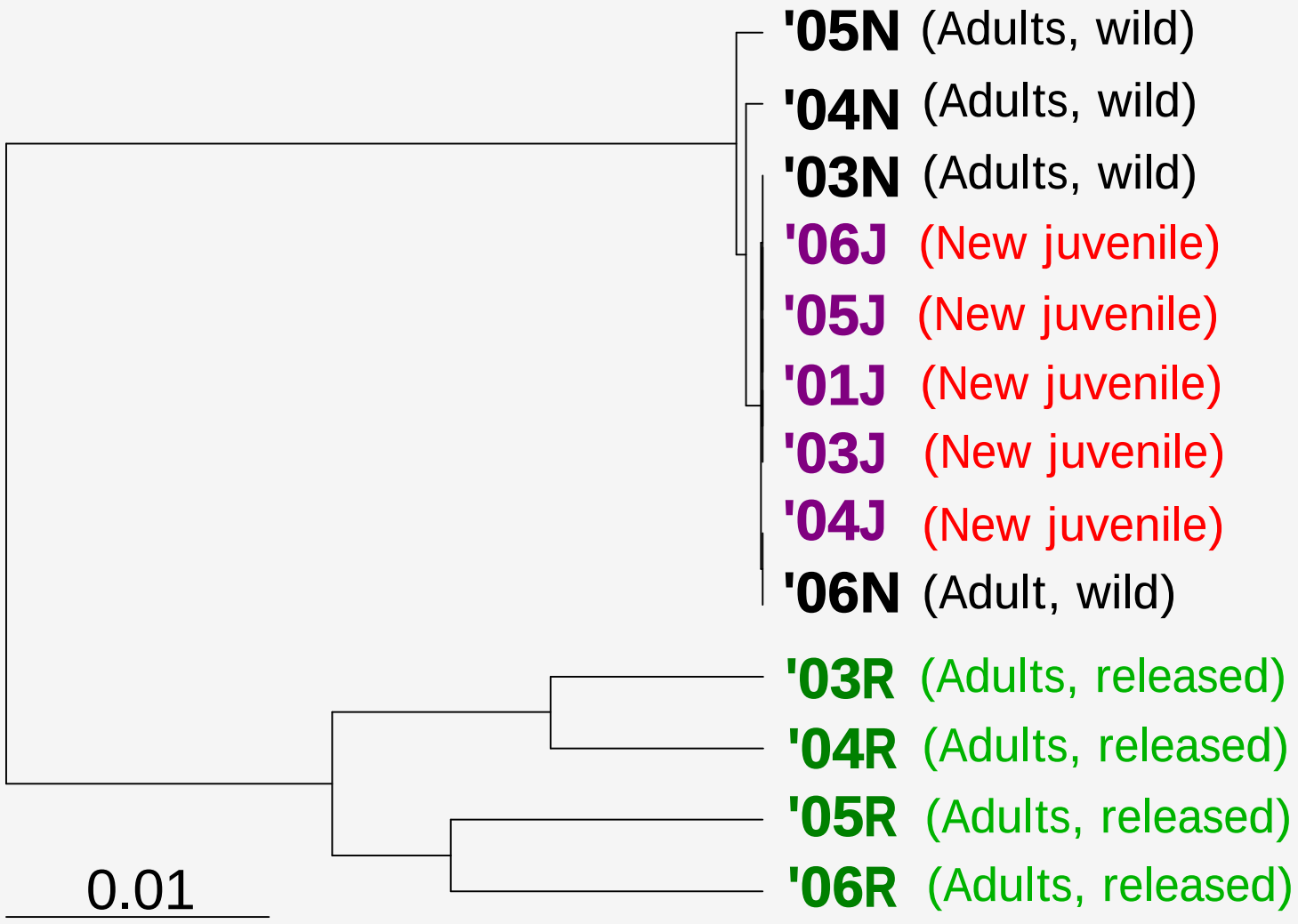

Jogashima
Google



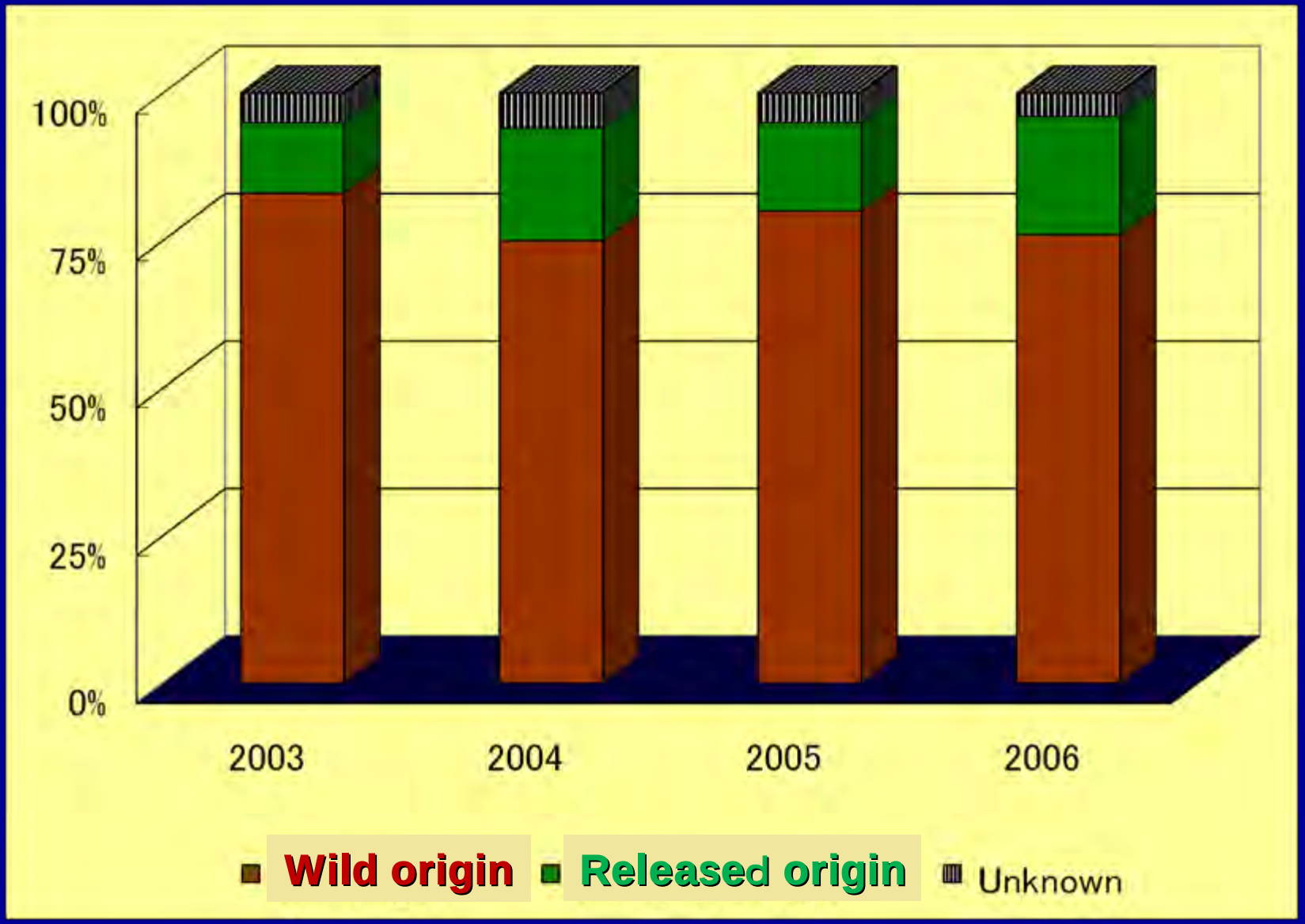
Changes of the density of adults and new juveniles around the release site (2001 – 2006)
Over 90% of the adults were released animals in each years

Genetic diversity in each population from 2003 to 2006

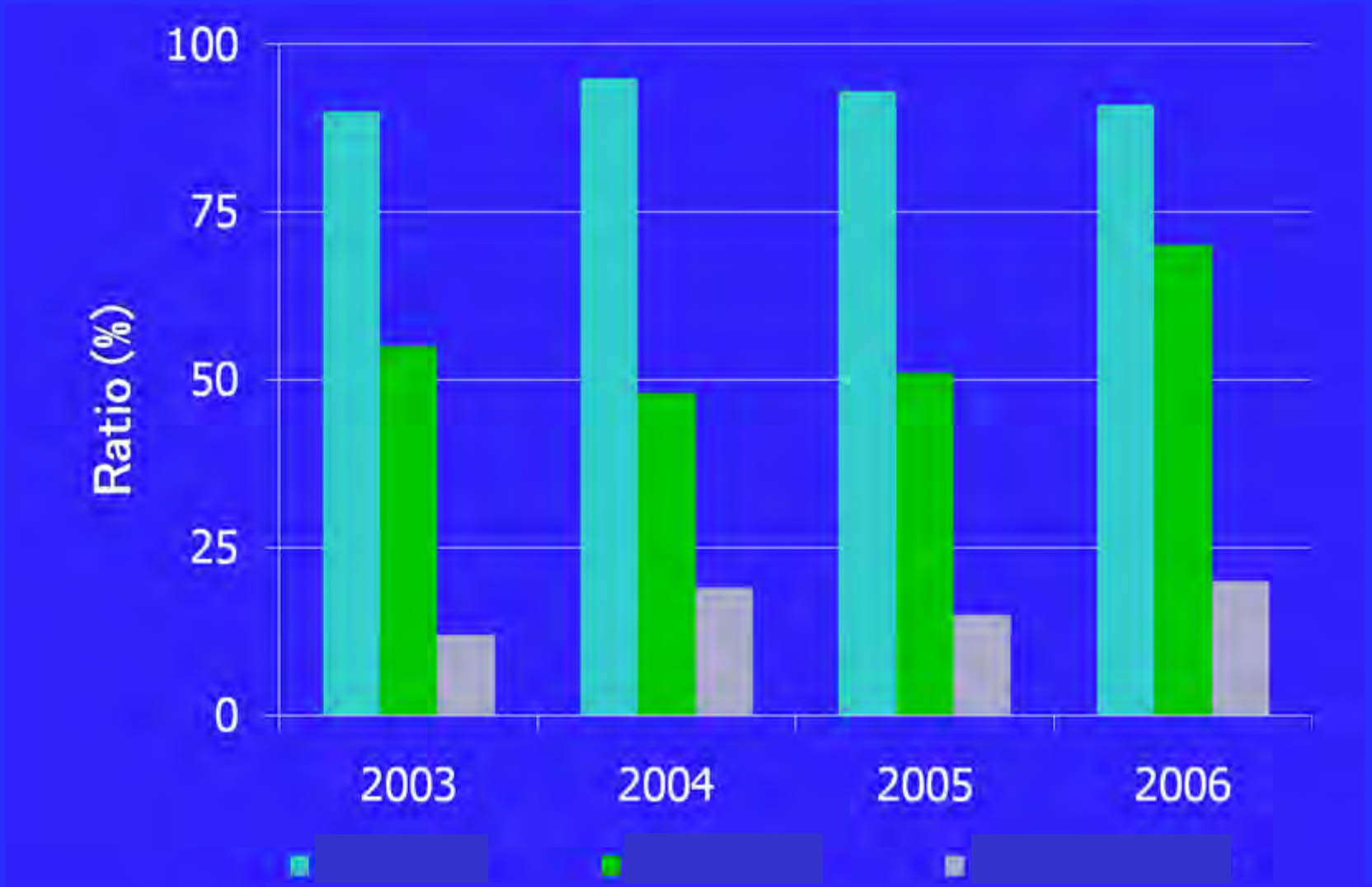
Population	No of year class	Allelic richness	Expected heterozygosity
Wild	4	8.1～8.6	0.592～0.615
Released	4	4.4～7.0	0.515～0.562
New juvenile	4	8.2～8.6	0.603～0.625



Genetic relationship among samples generated from pairwise F_{ST} values using UPGMA method



Result of assignment test of new juveniles at individual level in 2003 to 2006


100
75
50
25
0
Ratio (%)
2003
2004
2005
2006
Ratio of released animals around the testing site
Ratio of released animals in the Oshoro Bay
Ratio of the new juvenile originate from released animals

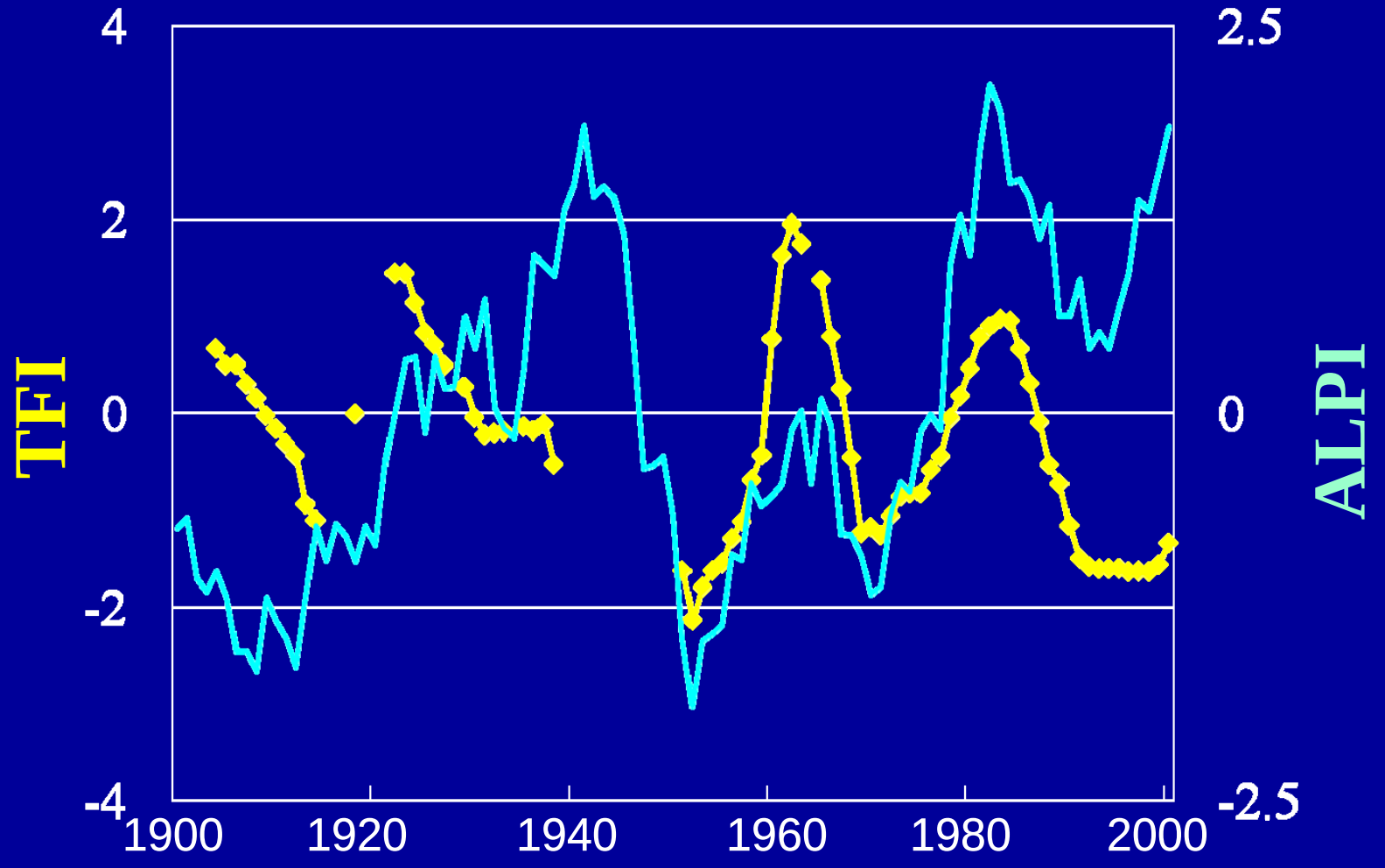
Summary

- We could make the **broodstock density** of testing site **higher with seedling. 90% of broodstock were released animals.**
- But, over 80% of new juvenile occurred around the testing site were **originate from wild broodstock.**
- Impact of seedling on reproduction could not be detected.

Issues

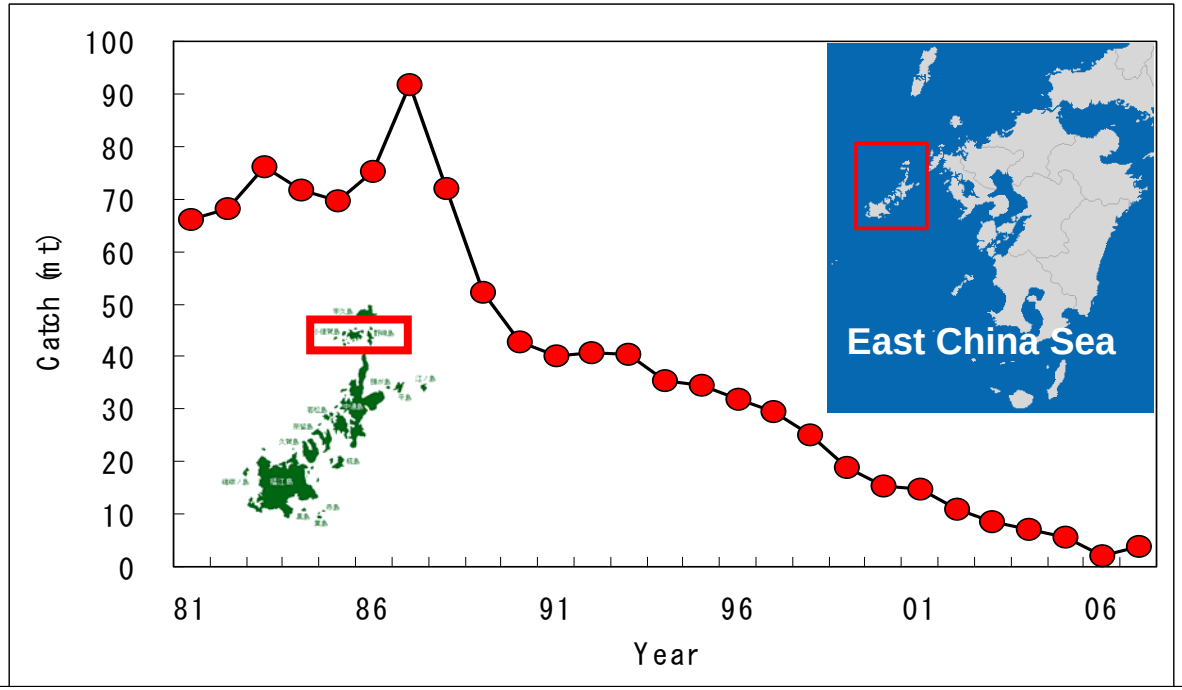
- Disperse and transportation of free-swimming larvae
- Suitable condition for brood stock

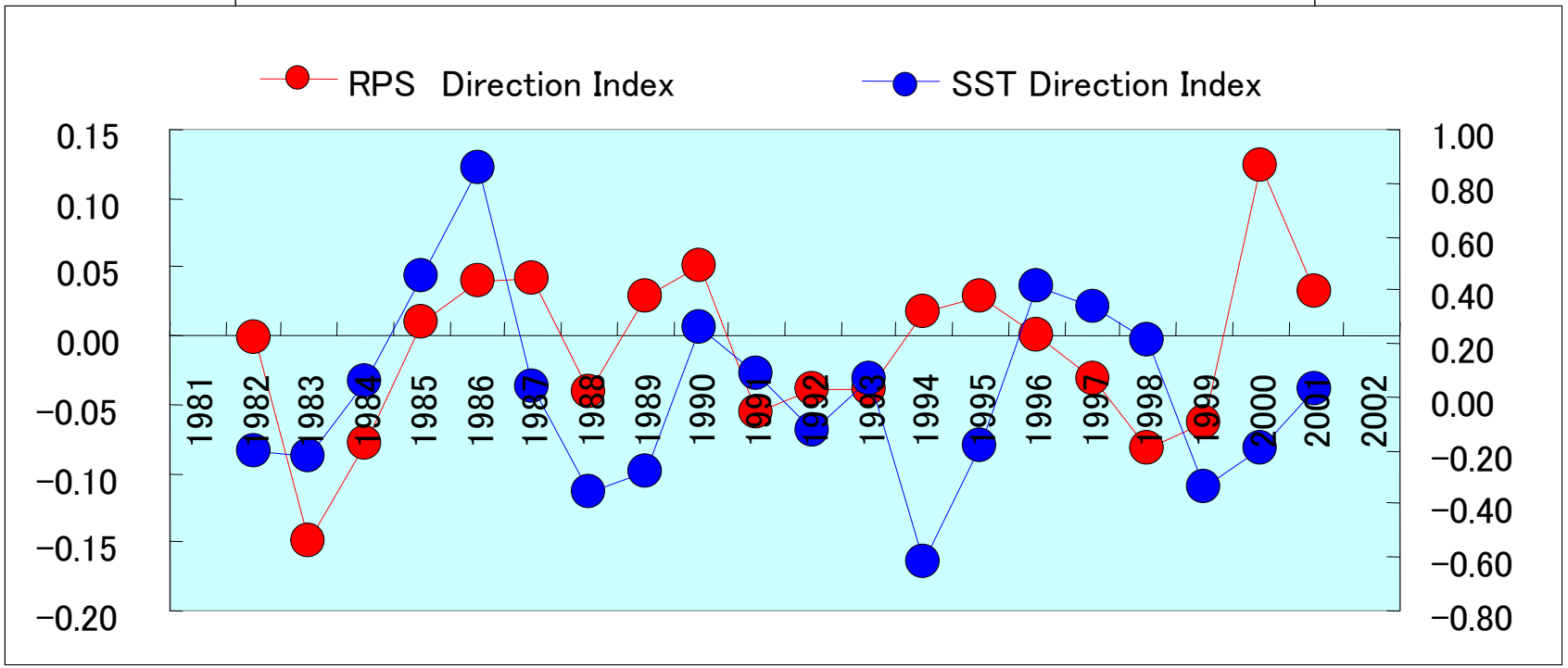
  geographical, biological, ecological…
- Reproductive ability of artificial produced animals

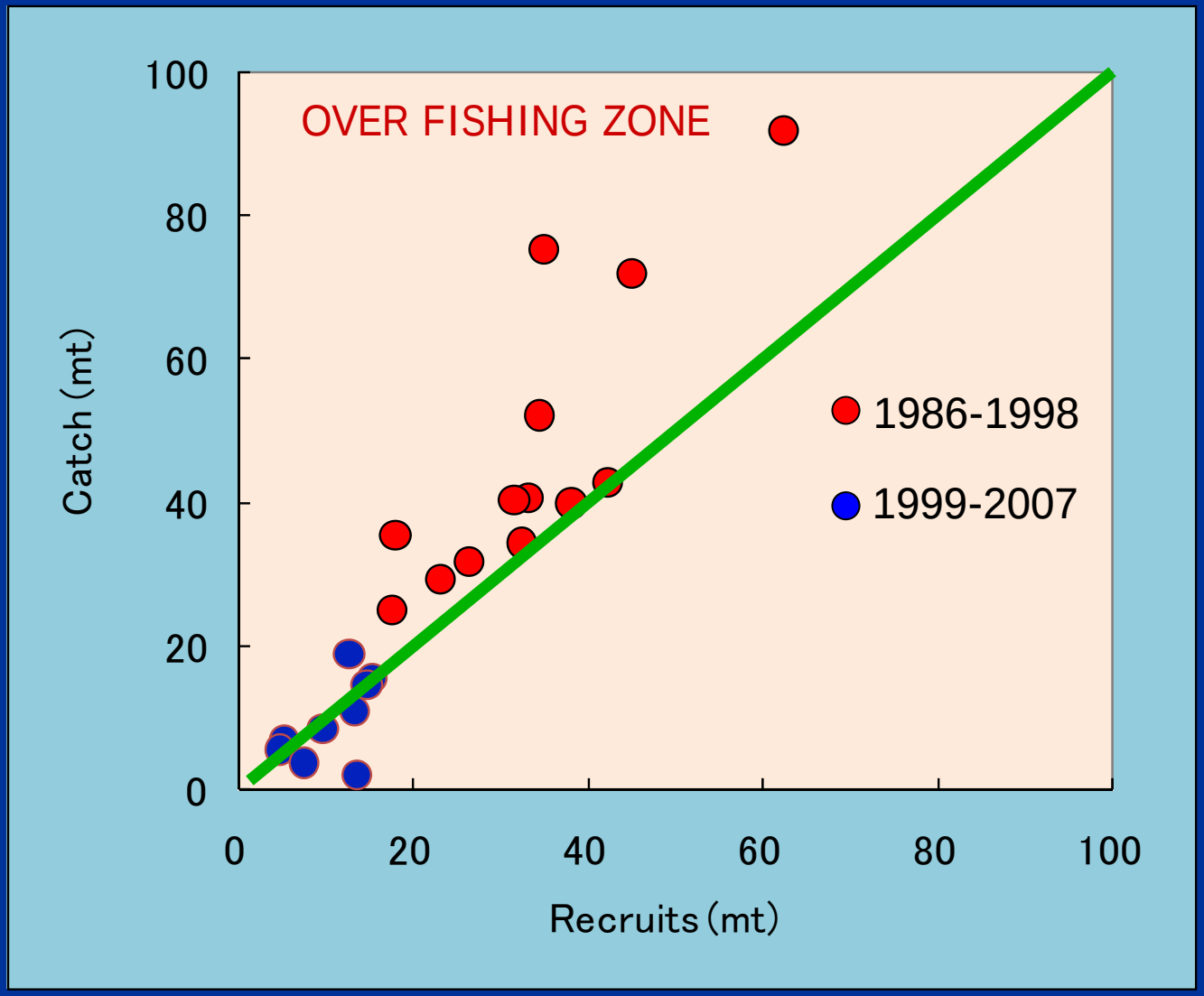


Tendency of abalone catches Fluctuation Index (TFI) and Aleutian Low Pressure Index (ALPI)

（Hayakawa *et.al.* 2007）


Catch (mt)
100
90
80
70
60
50
40
30
20
10
0
81
86
91
96
01
06
Year
East China Sea


RPS Direction Index
SST Direction Index
0.15
0.10
0.05
0.00
−0.05
−0.10
−0.15
−0.20
1.00
0.80
0.60
0.40
0.20
0.00
−0.20
−0.40
−0.60
−0.80
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002



Relationships between yearly recruits and catches in 1986-2007.

Abalone population management

- RPS (recruits per spawning stock biomass) and stock abundance are affected by sea water temperature condition in the short term.
- Over-fishing (including poaching) on brood stock cause depletion in the long term.
- Currently, seedling could not enhance recruits in many areas.
- Appropriate fishery management is indispensable for recovering abalone population independently of seedlings.

고마웠습니다.

コマウォッスムニダ

Genetic differentiation among samples using estimates of pairwise F_{ST} (above diagonal) and the probabilities (below)

	New juvenile population					Wild population				Released population			
	'01J	'03J	'04J	'05J	'06J	'03N	'04N	'05N	'06N	'03R	'04R	'05R	'06R
'01J	—	-0.002	0.000	-0.002	-0.004	-0.002	-0.001	-0.001	-0.005	0.070	0.027	0.038	0.076
'03J	0.74	—	0.001	0.000	-0.002	-0.001	0.003	0.004	0.001	0.072	0.032	0.046	0.081
'04J	0.44	0.32	—	0.000	-0.002	-0.001	0.001	0.002	-0.001	0.083	0.040	0.054	0.091
'05J	0.82	0.64	0.55	—	-0.002	-0.002	0.002	0.003	-0.002	0.070	0.030	0.044	0.076
'06J	0.92	0.95	0.90	0.91	—	-0.003	-0.001	0.001	-0.001	0.077	0.033	0.048	0.083
'03N	0.67	0.62	0.50	0.82	0.87	—	0.000	0.001	-0.001	0.068	0.025	0.040	0.070
'04N	0.63	0.02	0.16	0.10	0.59	0.45	—	0.003	0.002	0.082	0.042	0.054	0.084
'05N	0.58	0.02	0.12	0.04	0.30	0.33	0.06	—	0.002	0.076	0.036	0.043	0.076
'06N	0.94	0.32	0.51	0.91	0.74	0.54	0.11	0.17	—	0.066	0.026	0.040	0.074
'03R	0	0	0	0	0	0	0	0	0	—	0.016	0.030	0.048
'04R	0	0	0	0	0	0	0	0	0	0	—	0.018	0.035
'05R	0	0	0	0	0	0	0	0	0	0	0	—	0.024
'06R	0	0	0	0	0	0	0	0	0	0	0	0	—