Flounder Stock Enhancement: Post-Release Performance and Assessment of Cage Conditioned Japanese Flounder, *Paralichthys olivaceus*, in Wakasa Bay, Japan

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Domestic Fisheries Division
Office of Sustainable Fisheries
NMFS/NOAA

Flatfish Fisheries

- flounder, halibut, turbot, sole, fluke, etc.
- desirable and highly priced product
- commercial and recreational
- catch of natural populations declining
- stock enhancement may help stabilize and/or restore catch

Flatfish stocking efforts in JP & US

JAPAN
(1977-2011)

Japanese flounder ½ billion
(Paralichthys olivaceus)

marbled flounder 40 million
(Pseduopleuronectes yokohomae)

barfin flounder 0.3 million
(Verasper moseri)

+ at least 5 other species of flatfish

US
(1999-2011)

winter flounder 27494
(Pseduopleuronectes americanus)

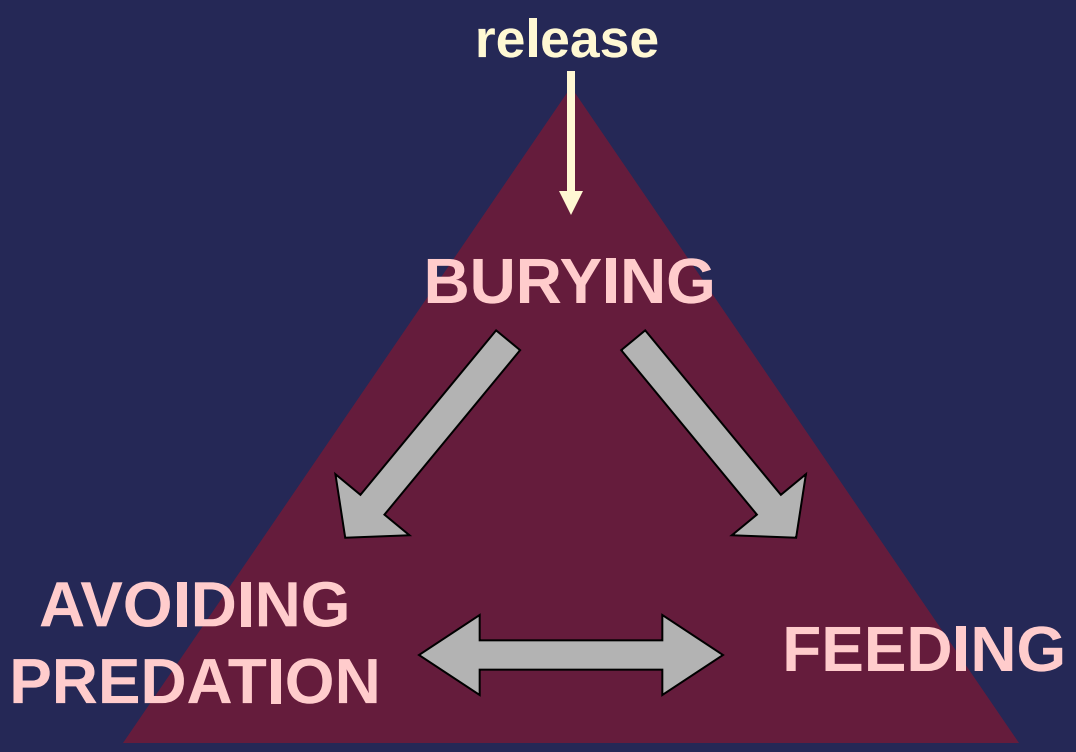
southern flounder 19057
(Paralichthys lethostigma)

summer flounder 1546
(Paralichthys dentatus)

TOTAL = 48097

TOTAL = A LOT!

Essential behaviors for released fish



Acclimation cage conditioning

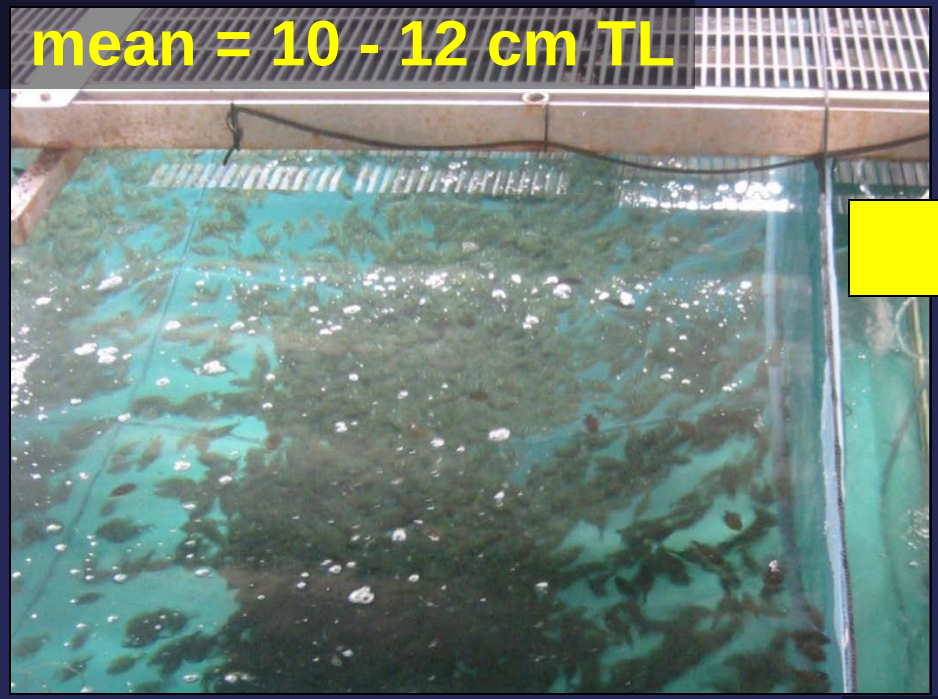
may allow hatchery fish to experience:

- substrate/sediments
- wild (live) food sources
- predator-free existence

CAN ACCLIMATION CAGE CONDITIONING IMPROVE THE STOCKING OF JUVENILE JAPANESE FLOUNDER?

I. LONG-TERM BENEFITS: field assessment
- movements
- recapture rates
- growth

II. IMMEDIATE BENEFITS: experimental trials
- burying
- feeding
- predator avoidance


mean = 10 - 12 cm TL

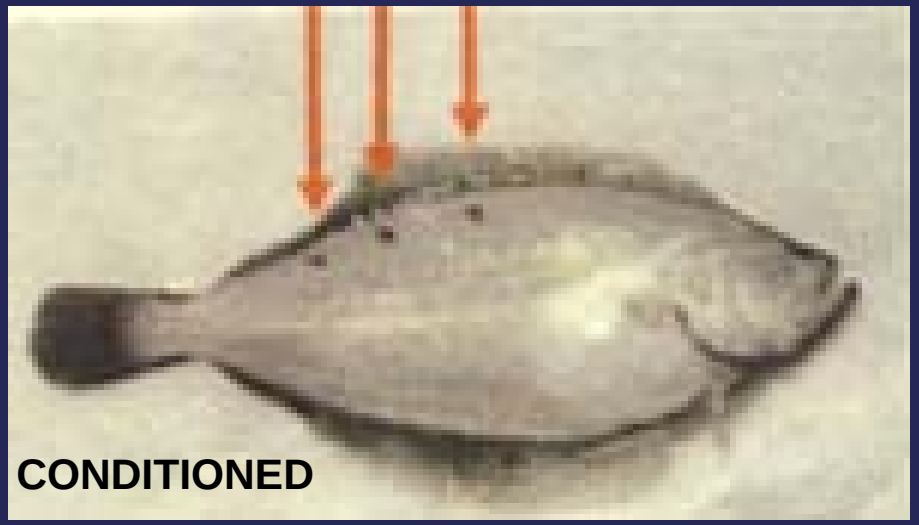
late June/early July

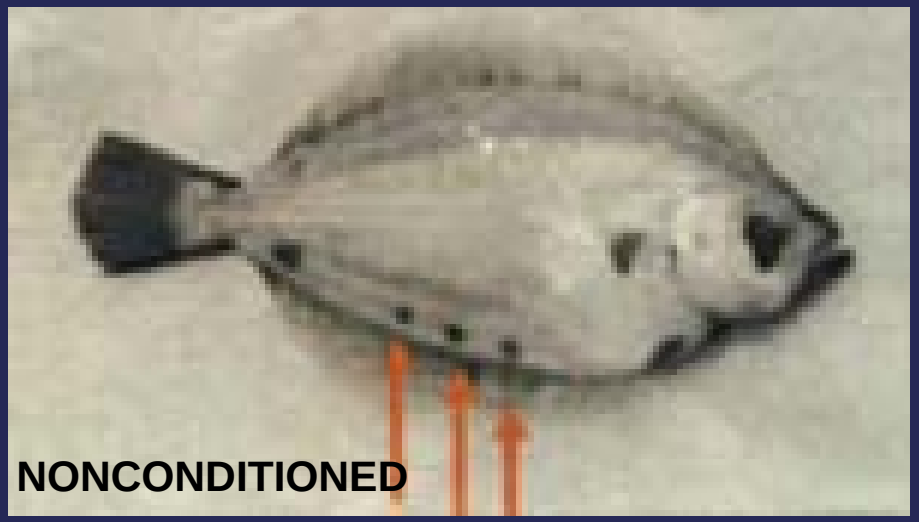
Mitutoyo
67.71
ORIGIN
ON/OFF
ZERO
ABS

up to ~1 month post release
FK

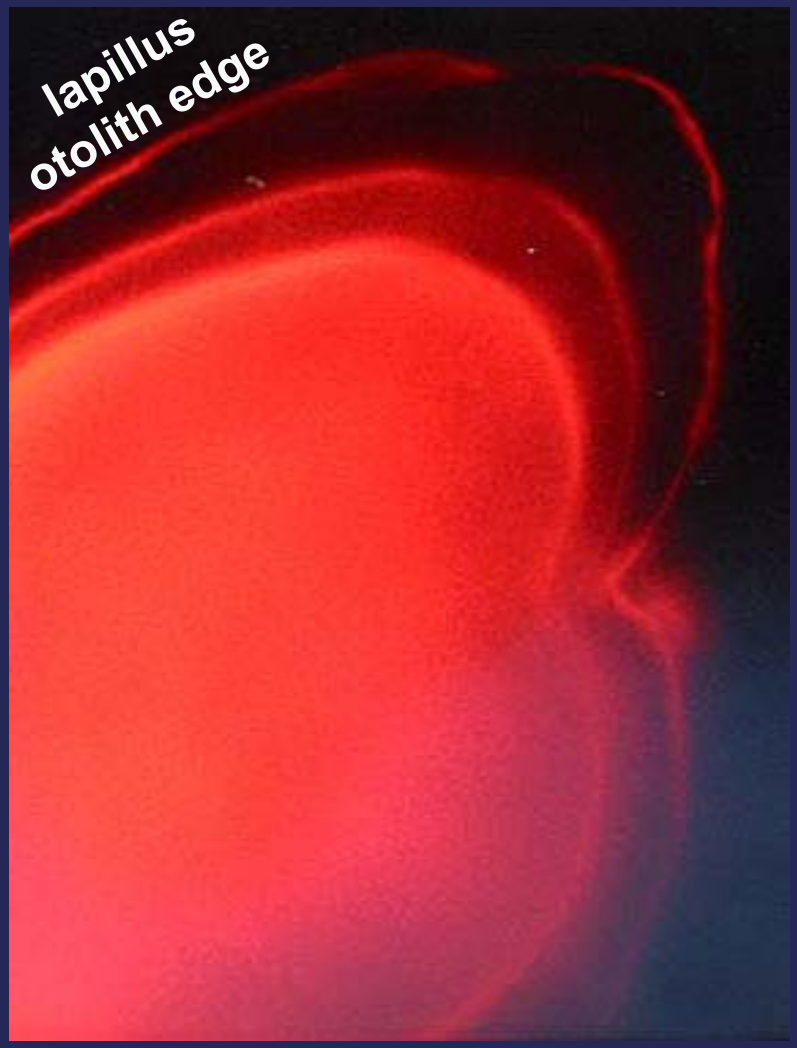
Marking methods

branding

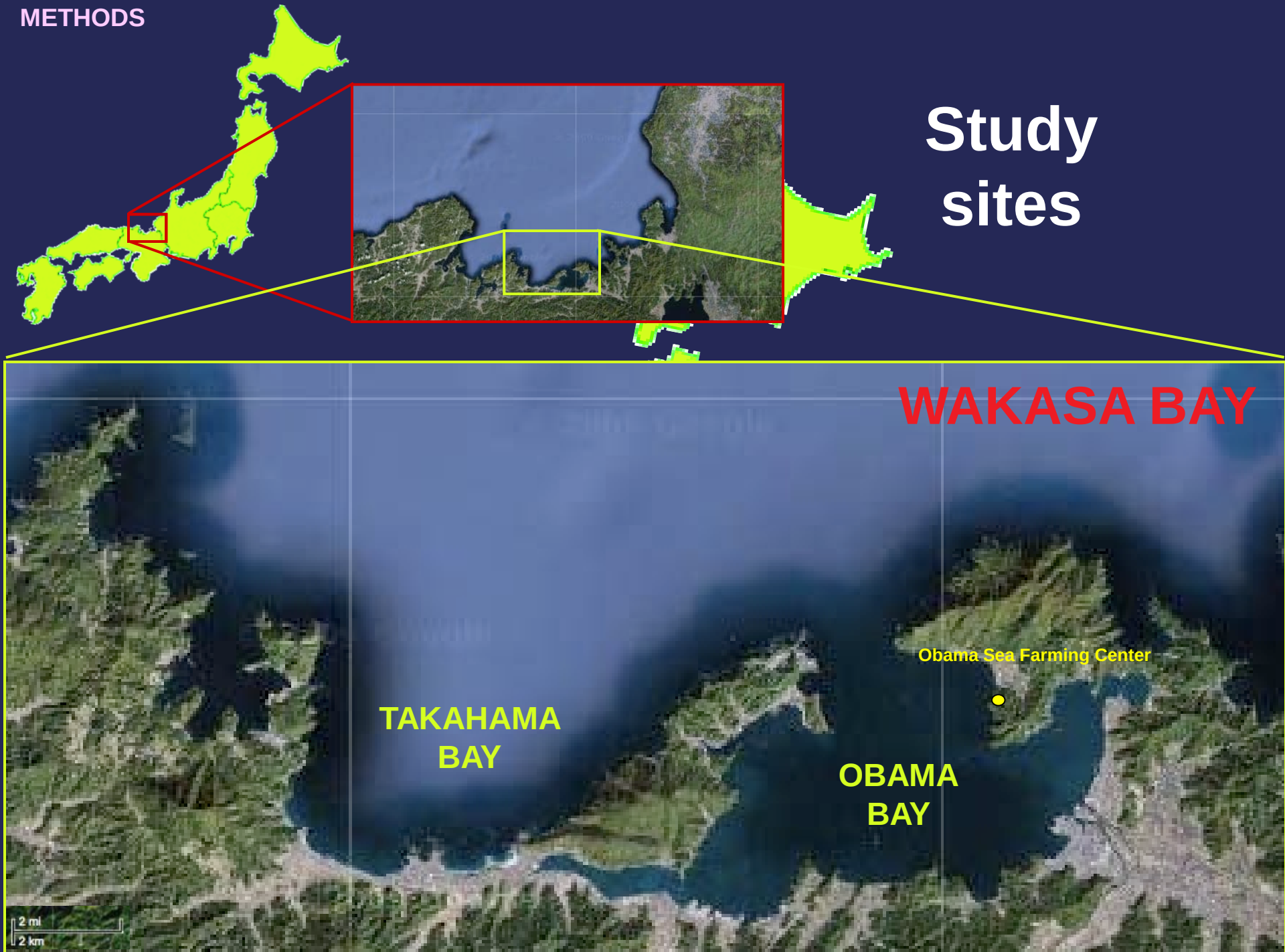


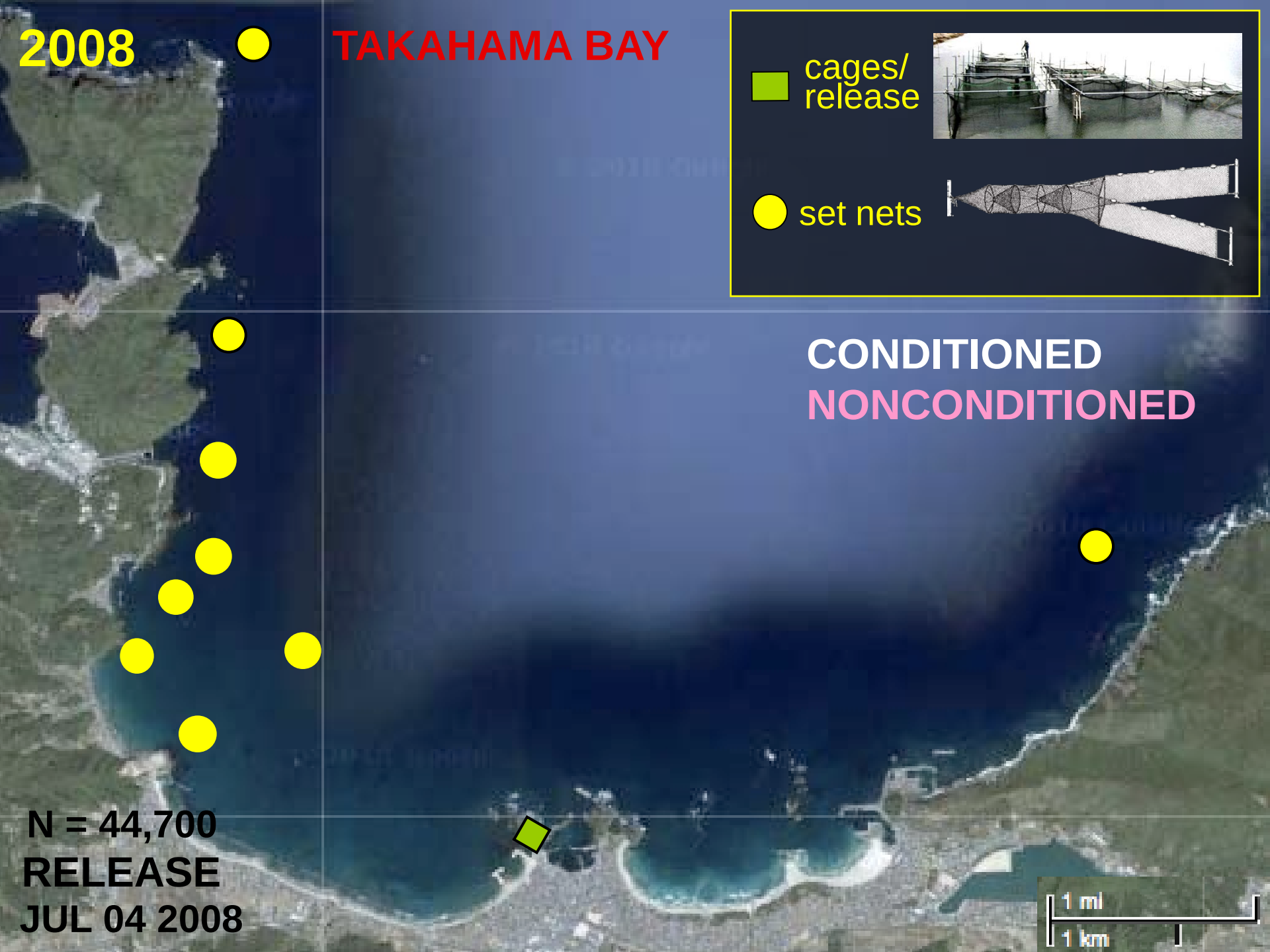


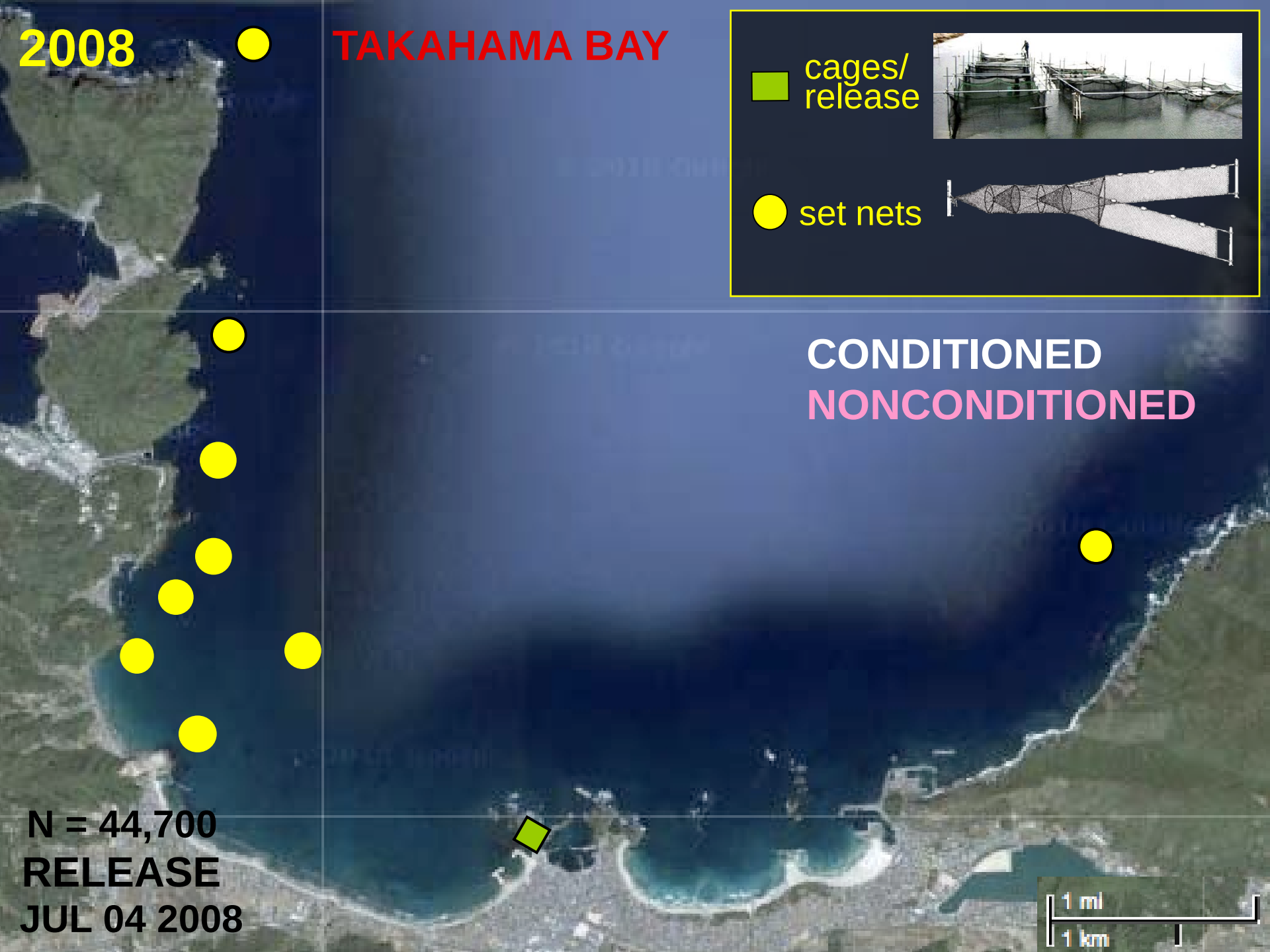
ALC dye



Study sites


WAKASA BAY
Obama Sea Farming Center
TAKAHAMA BAY
OBAMA BAY
2 mi
2 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
N = 44,700
RELEASE
JUL 04 2008
1 mi
1 km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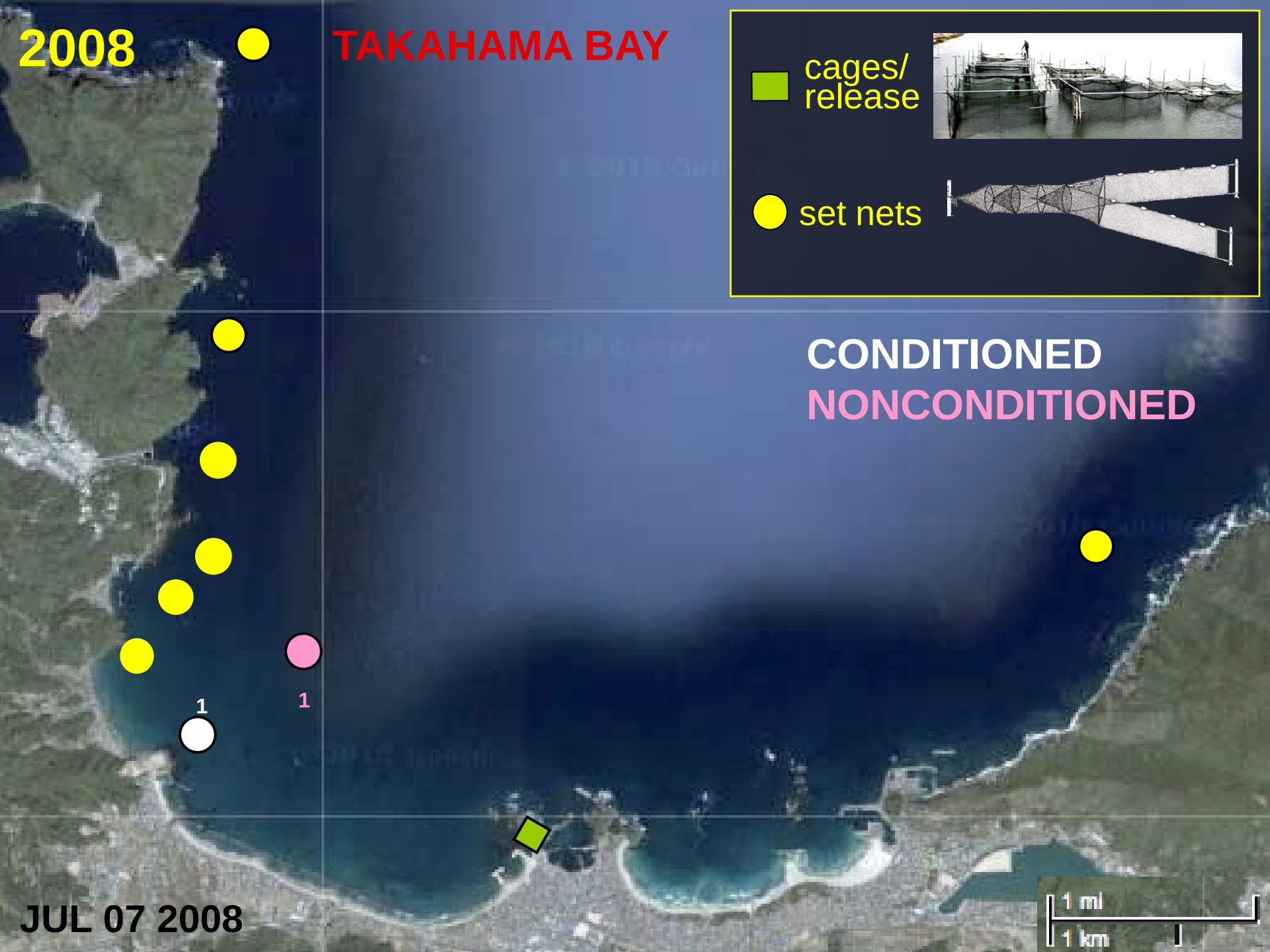
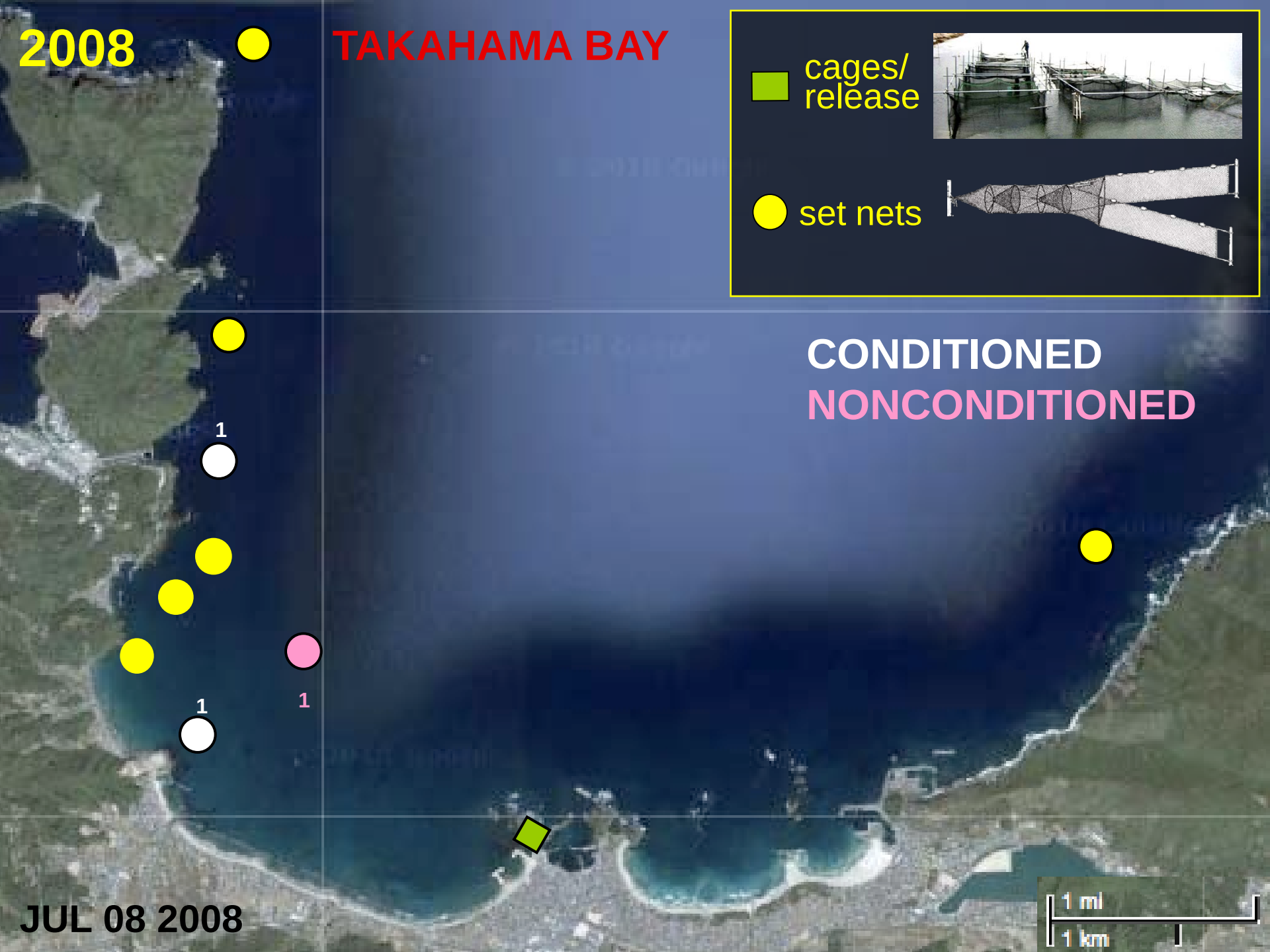
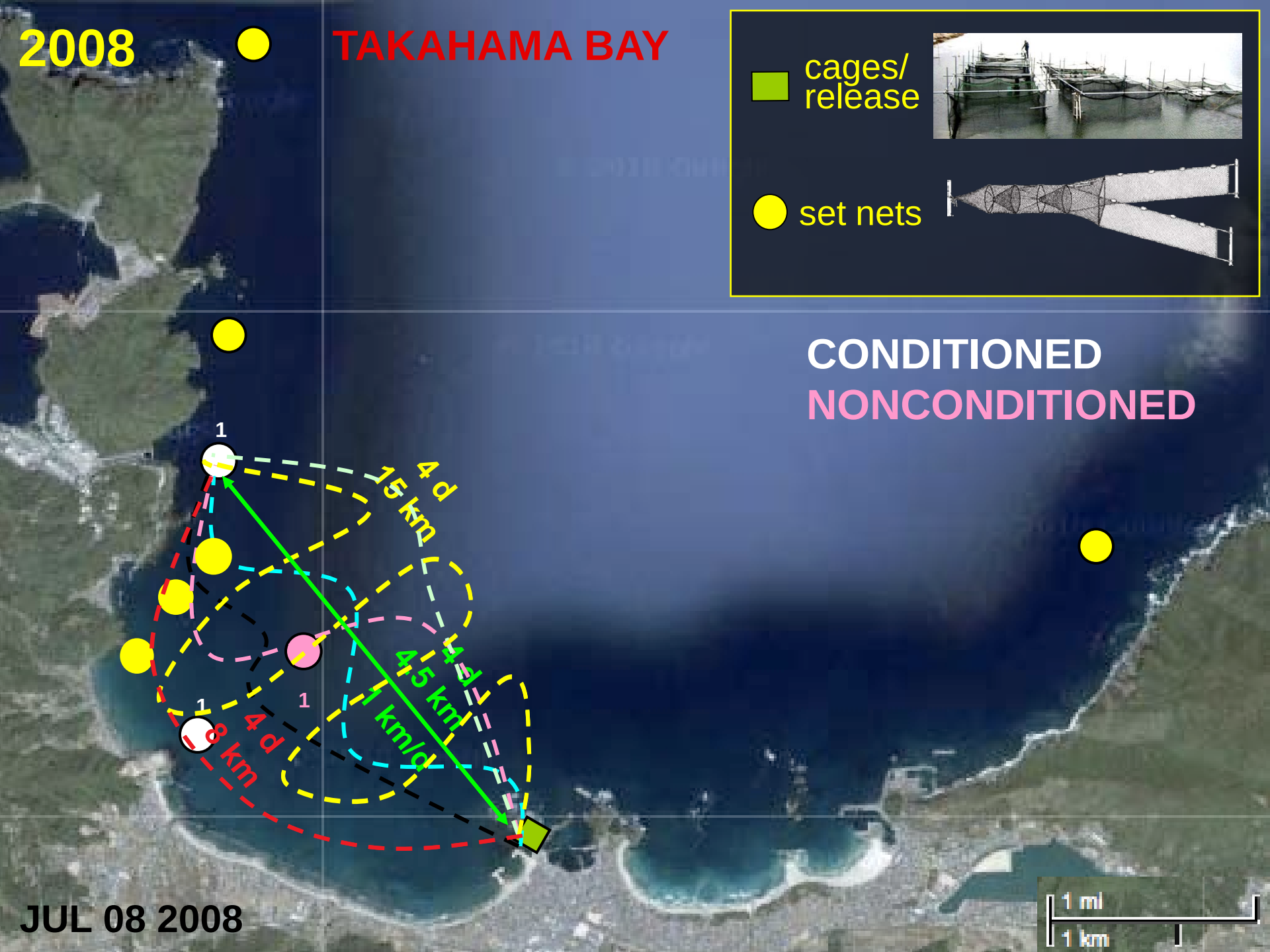
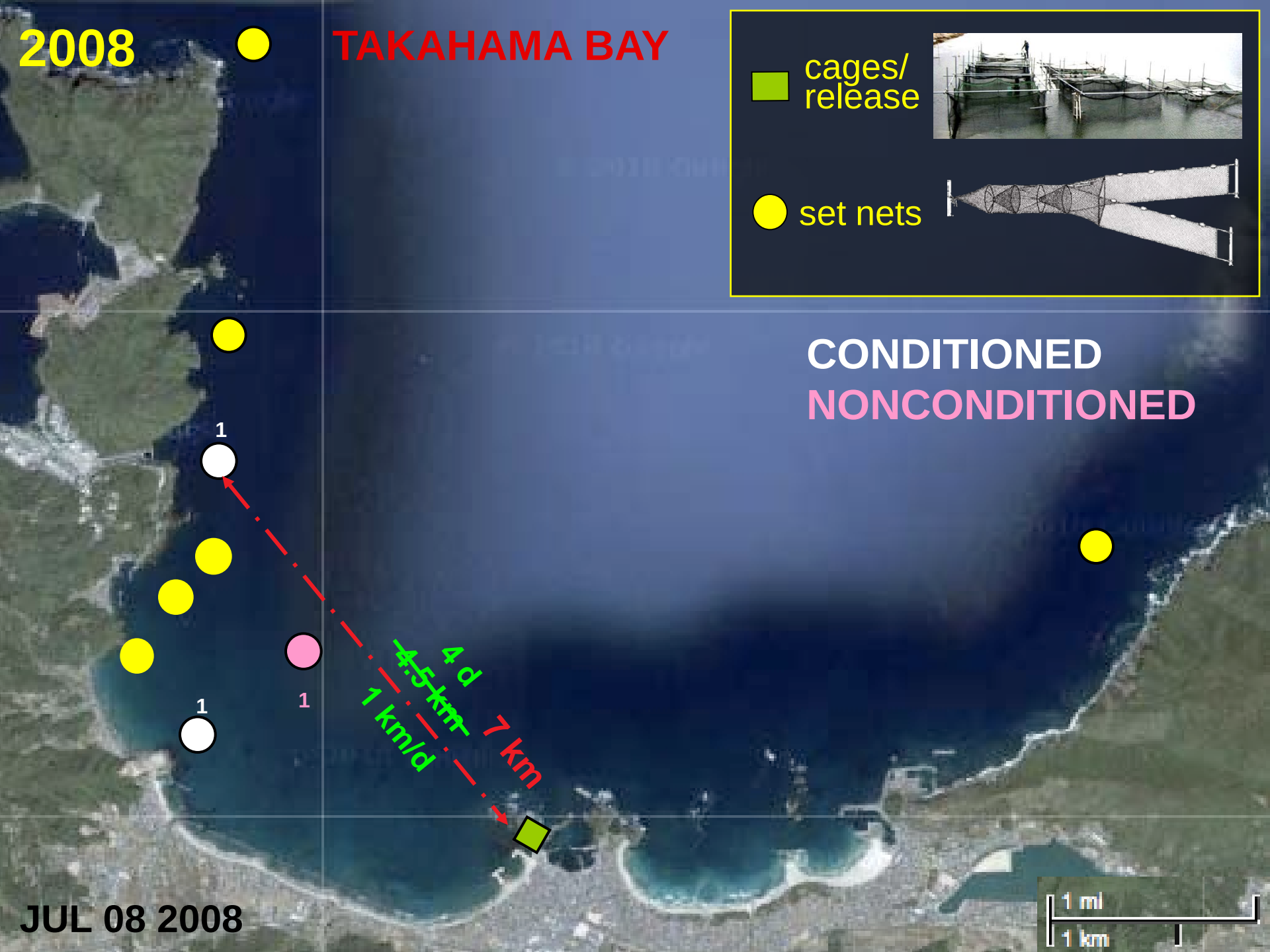
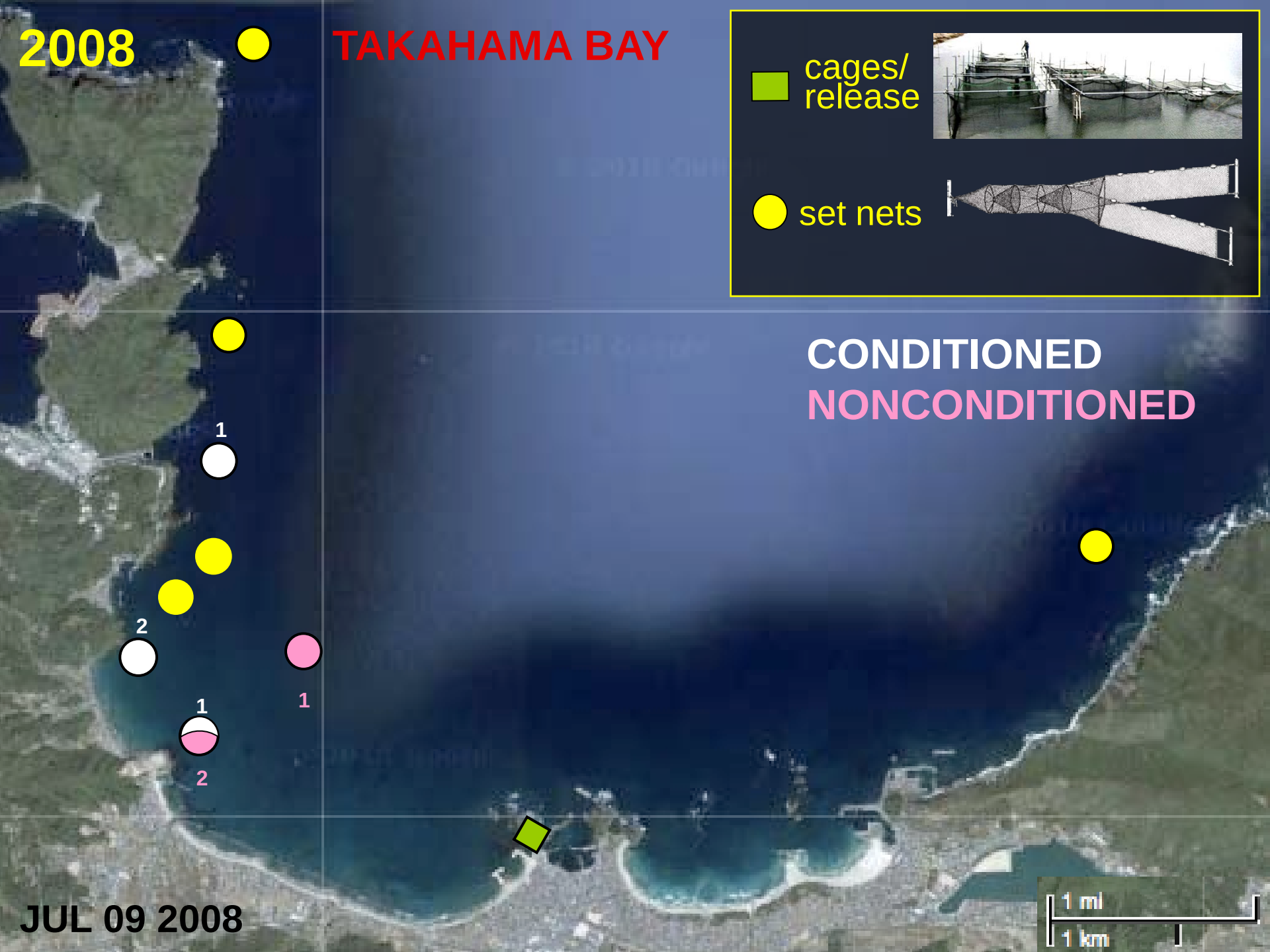
cages/ release
set nets
CONDITIONED
NONCONDITIONED
N = 44,700
RELEASE
JUL 04 2008
1 mi
1 km

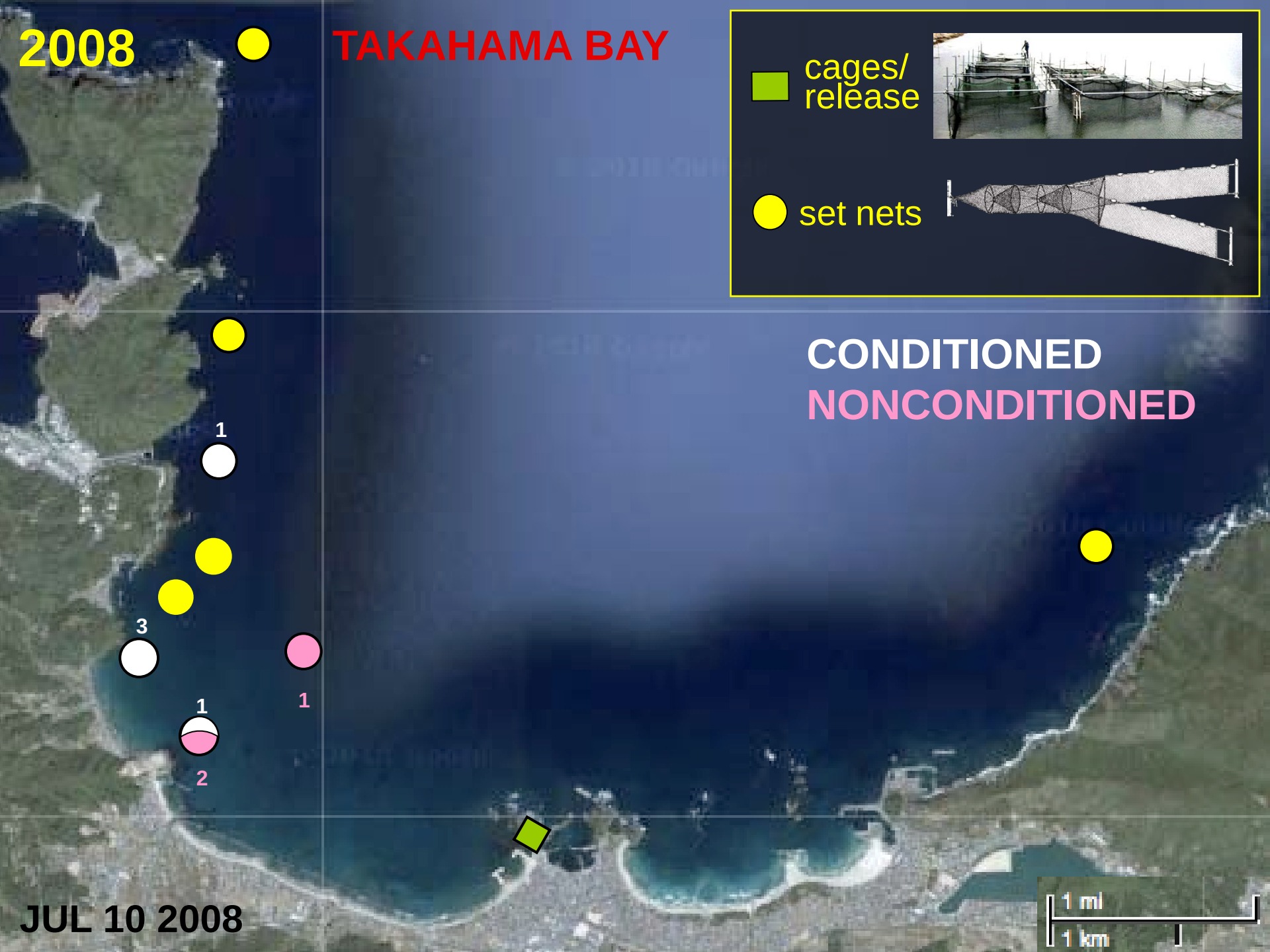

2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
1
JUL 07 2008
1 mi
1 km

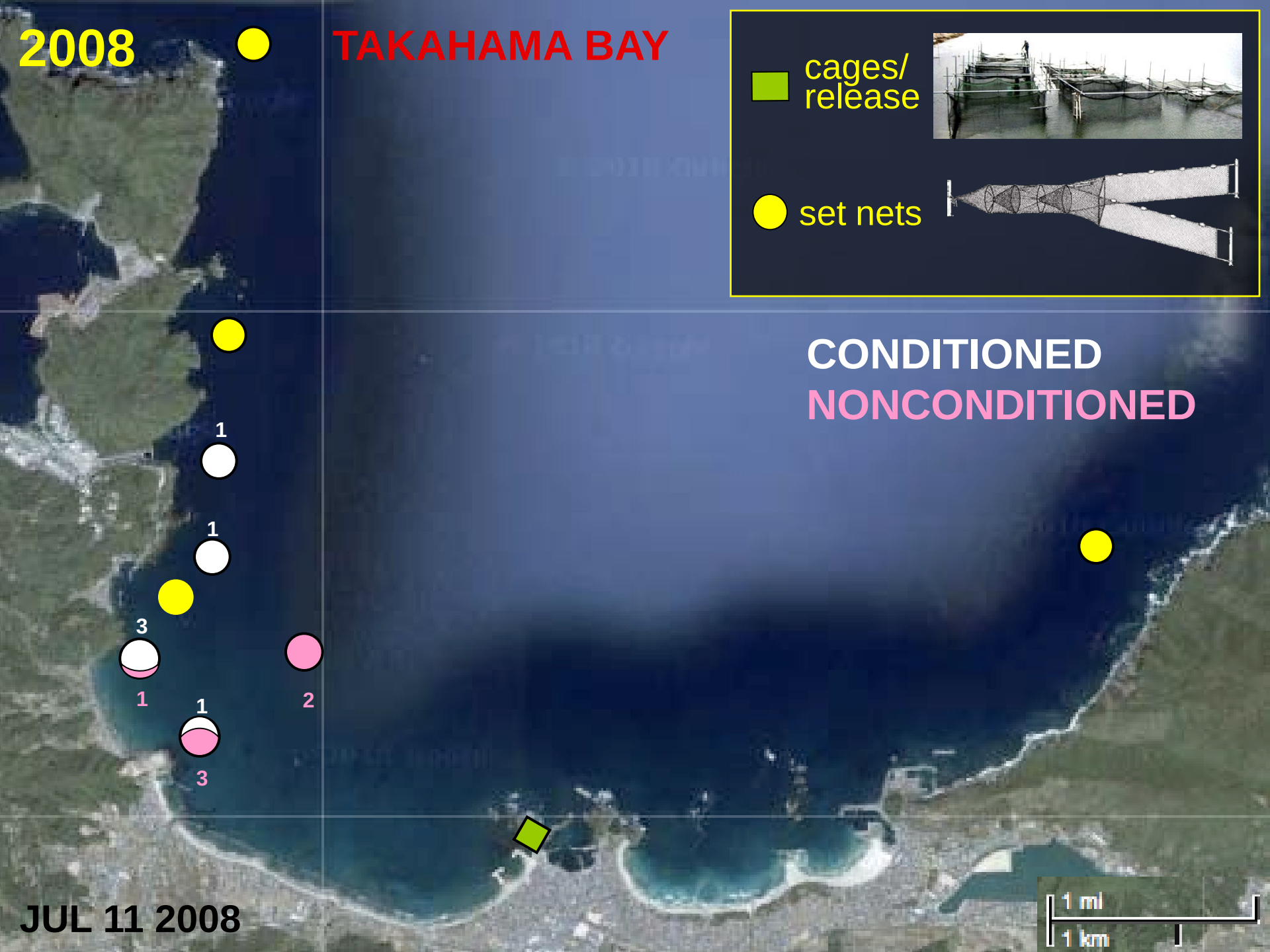

2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
1
1
JUL 08 2008
1 mi
1 km

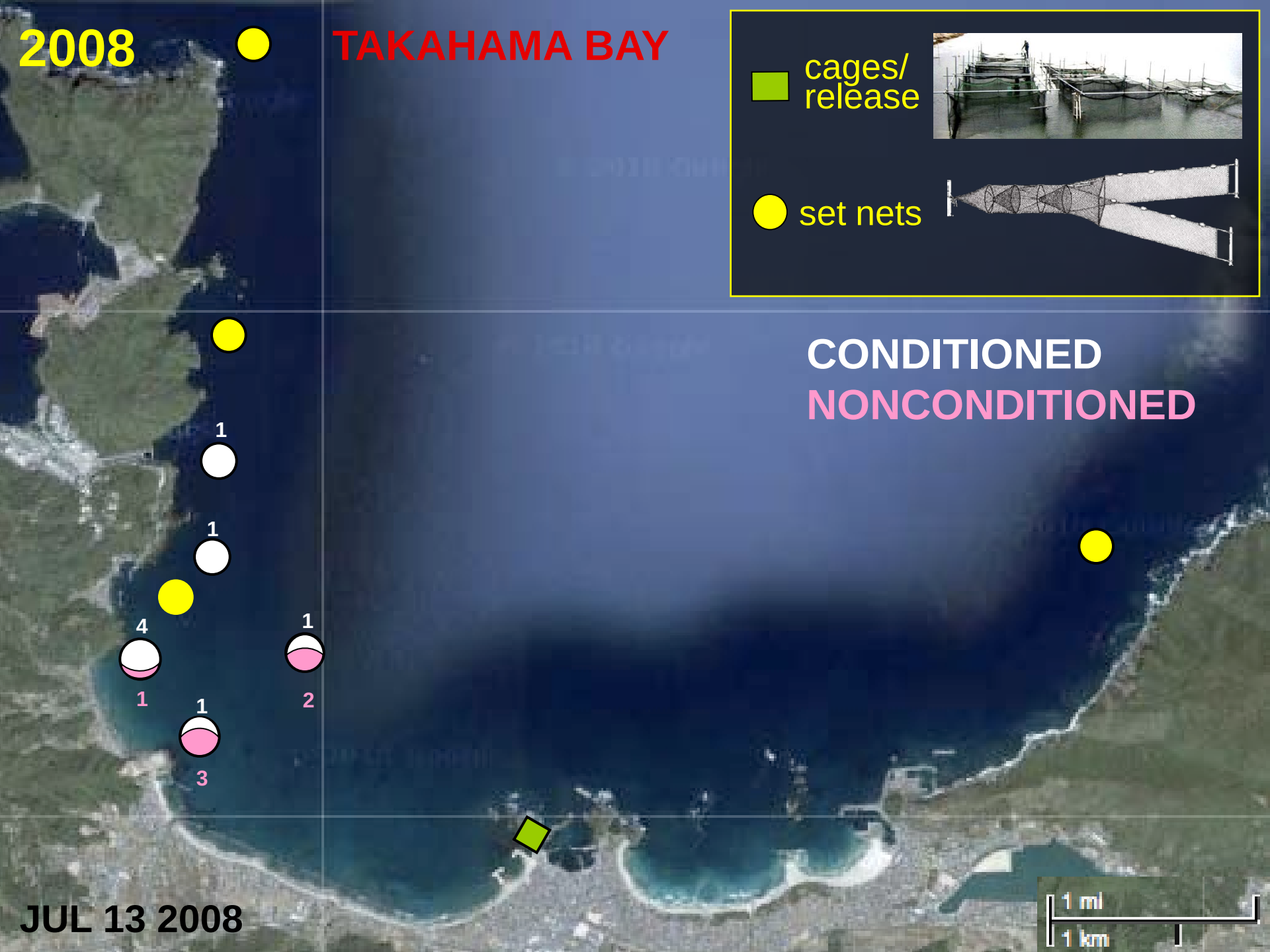

2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
1
1
4 d
15 km
4 d
45 km
1 km/d
4 d
8 km
JUL 08 2008
1 mi
1 km

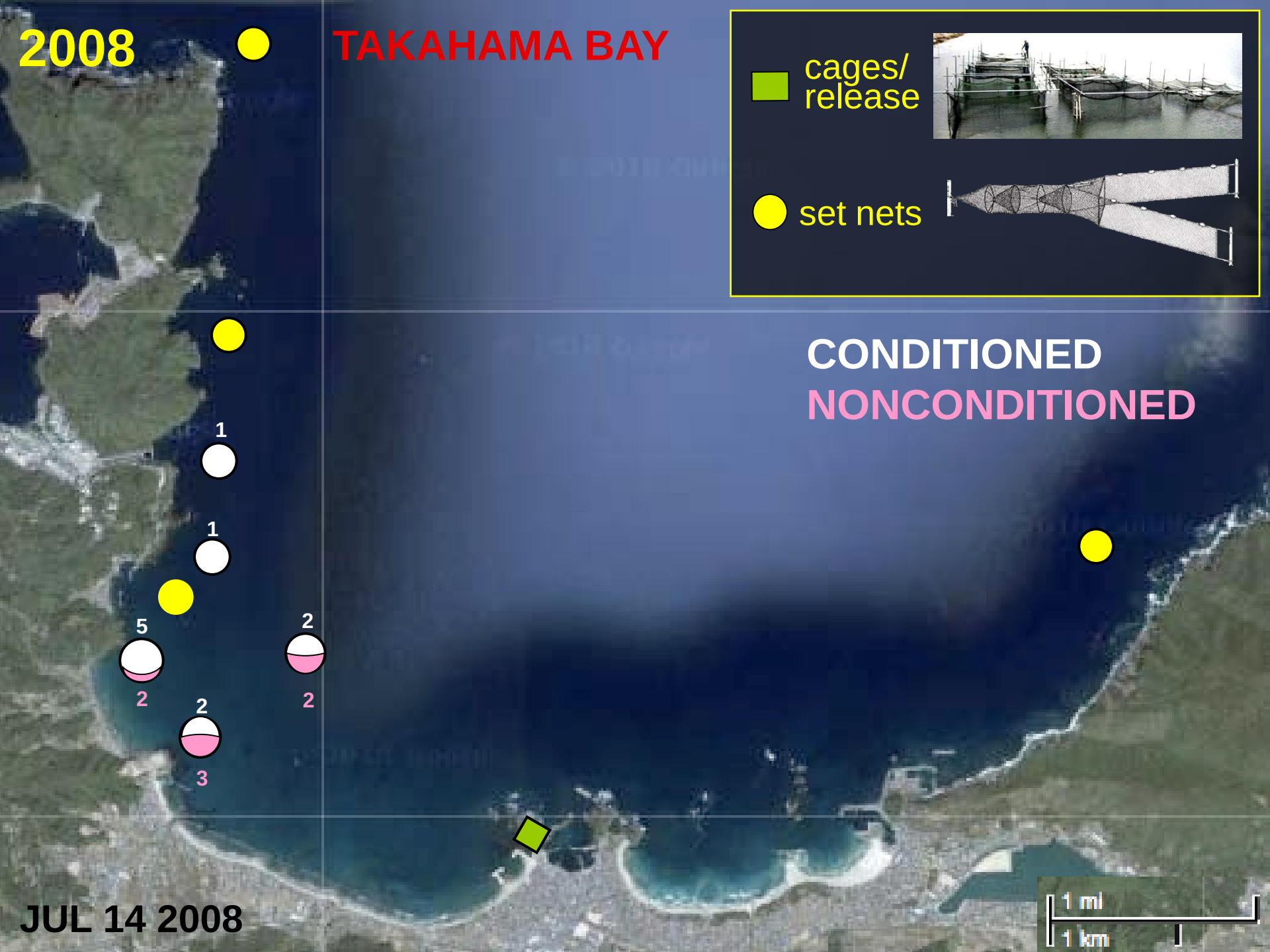

2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
1
1
4 d
4.5 km
1 km/d
7 km
JUL 08 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
2
1
1
2
JUL 09 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
3
1
1
2
JUL 10 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
1
3
1
2
1
3
JUL 11 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
1
4
1
1
1
2
3
JUL 13 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
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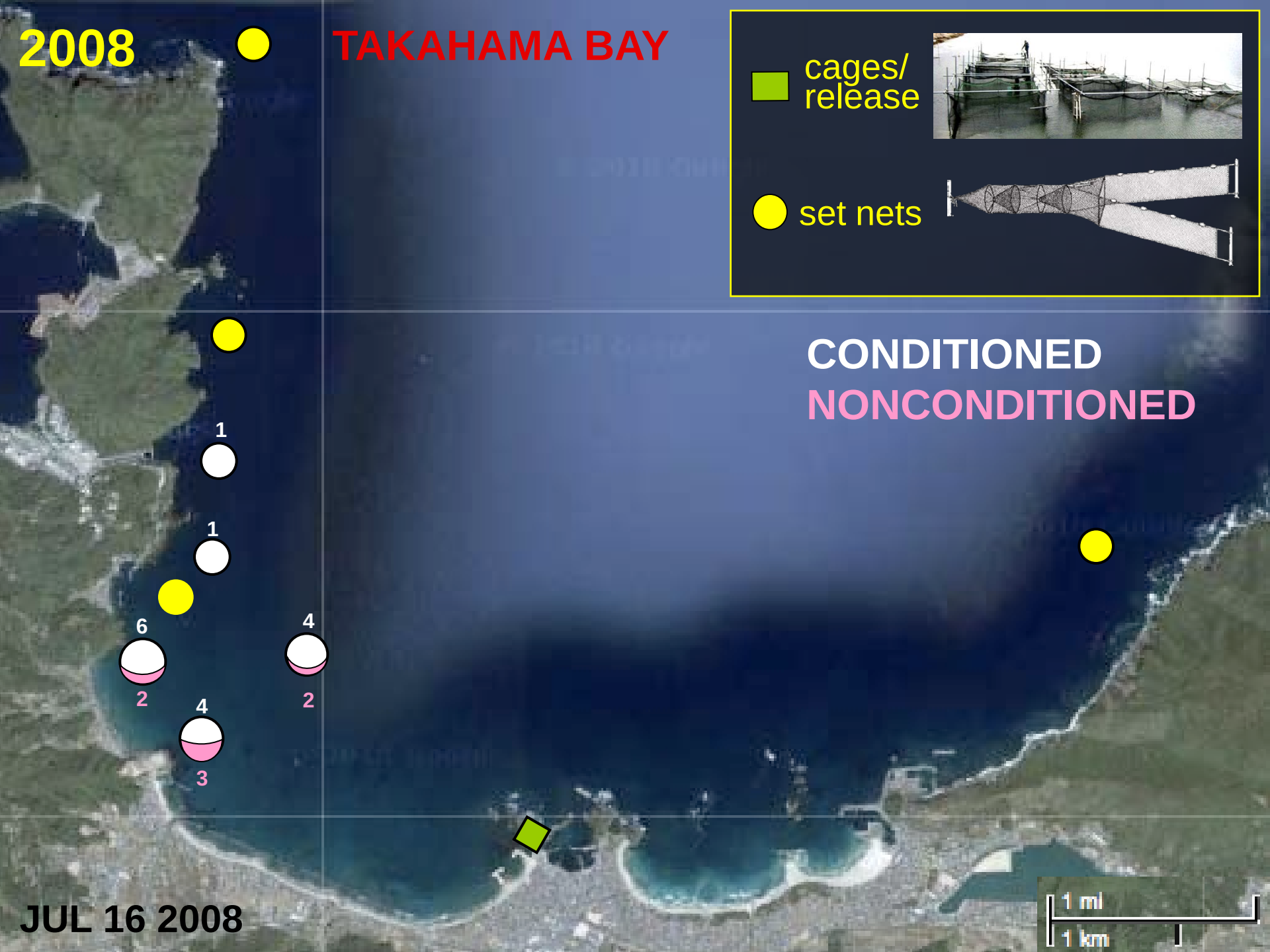
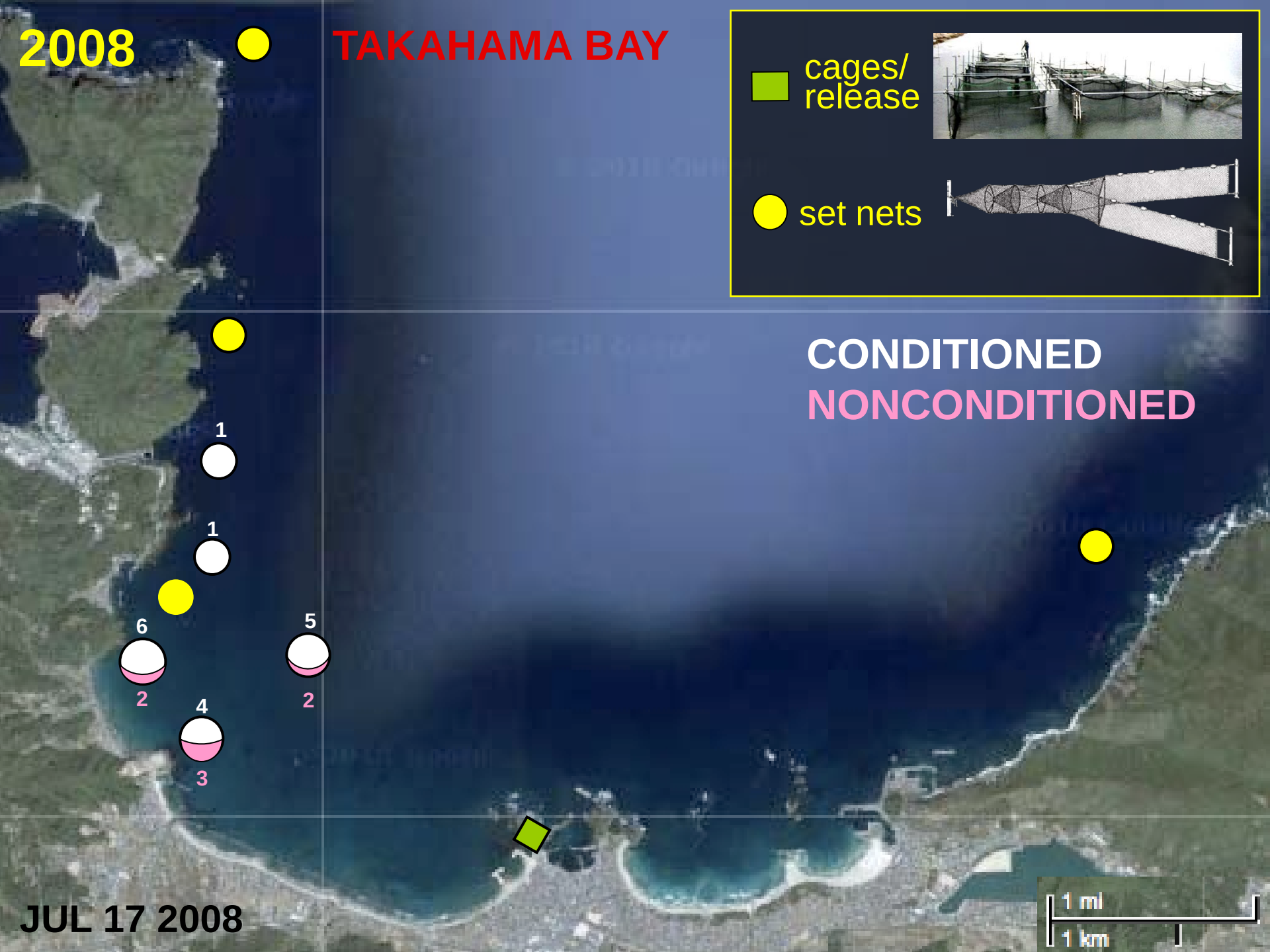
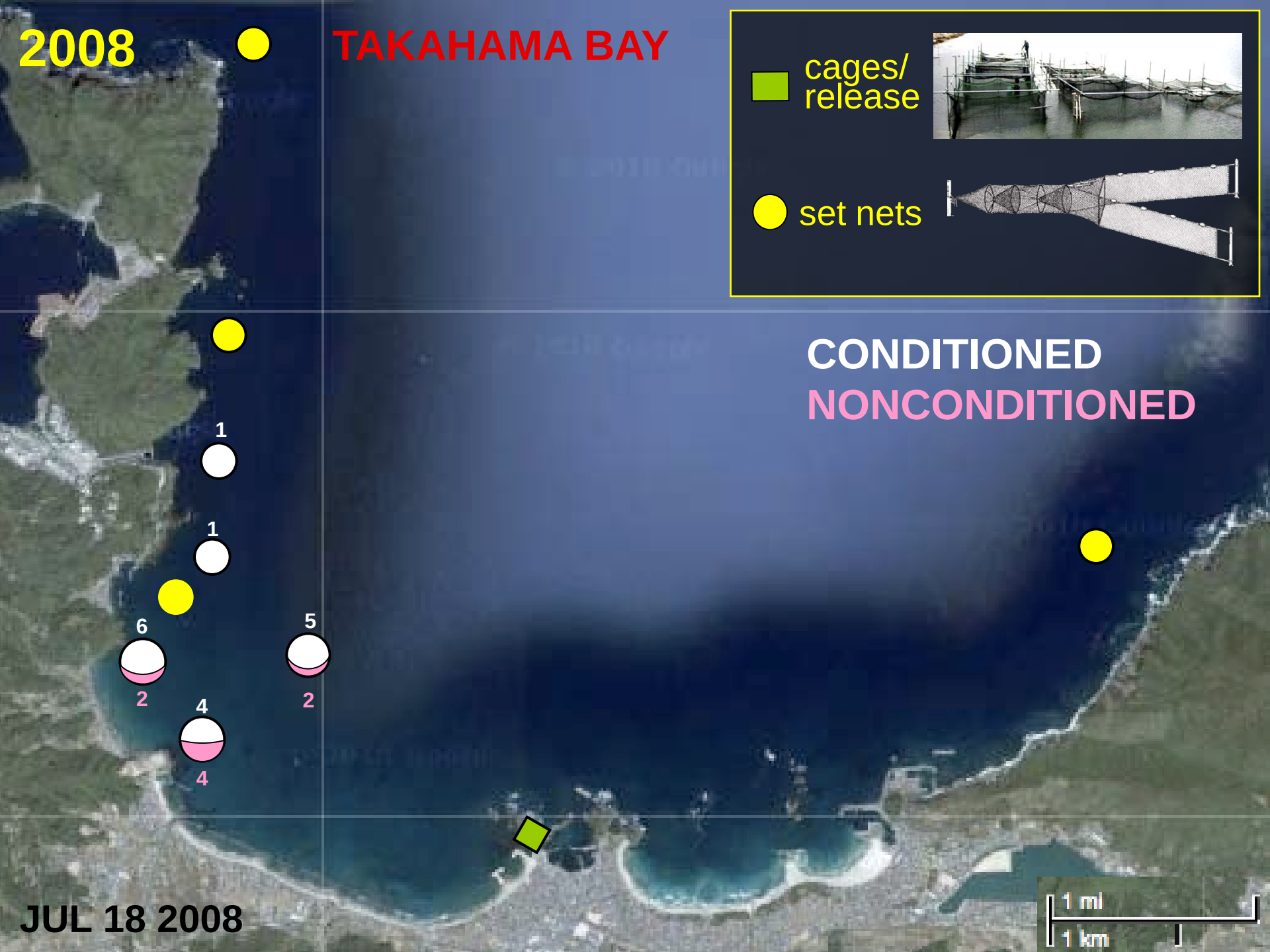
1
5
2
2
2
2
3
JUL 14 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
1
6
2
4
2
4
3
JUL 16 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
1
6
2
5
2
4
3
JUL 17 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
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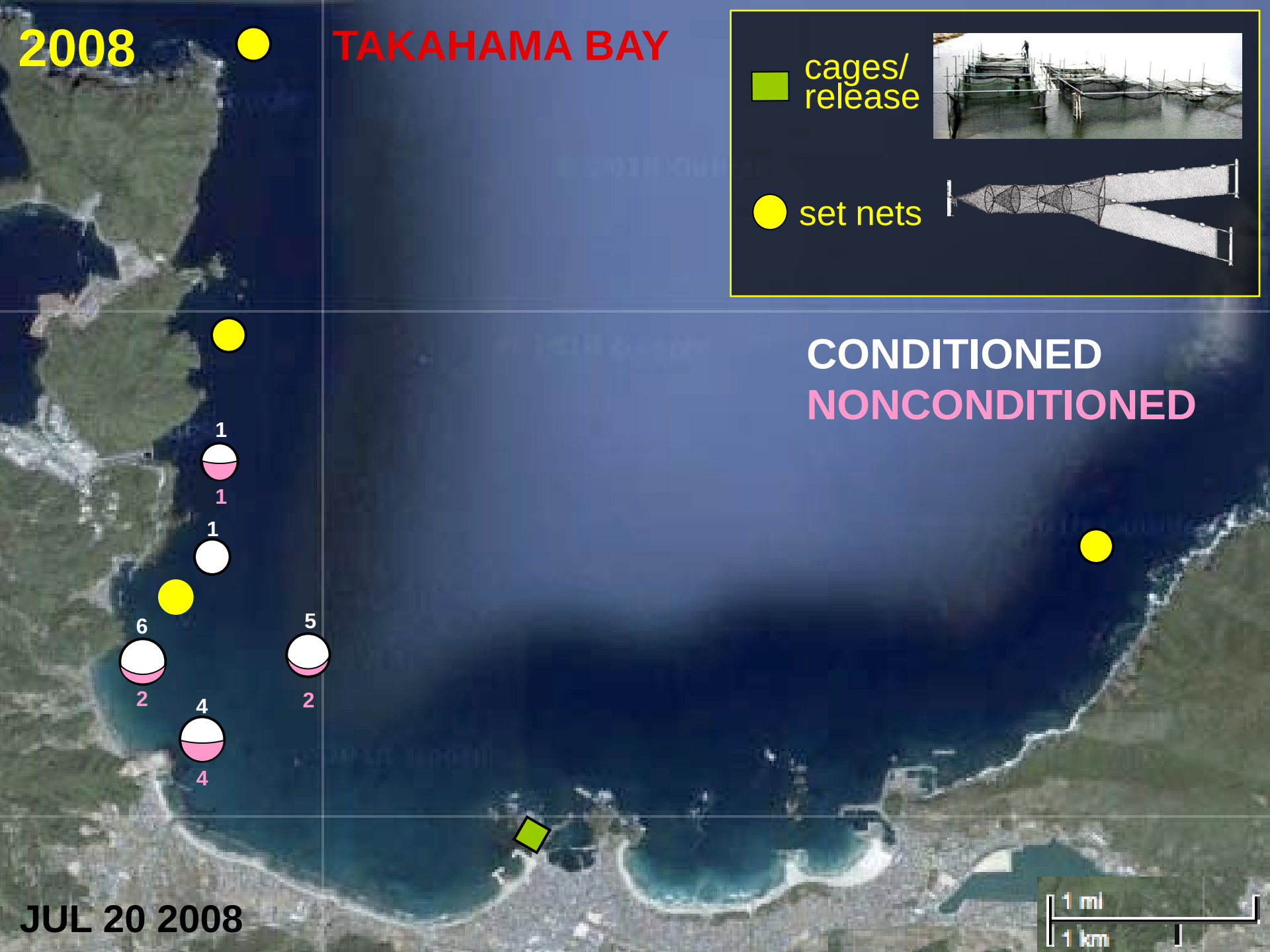
1
6
2
5
2
4
4
JUL 18 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
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NONCONDITIONED
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1
1
6
2
5
2
4
4
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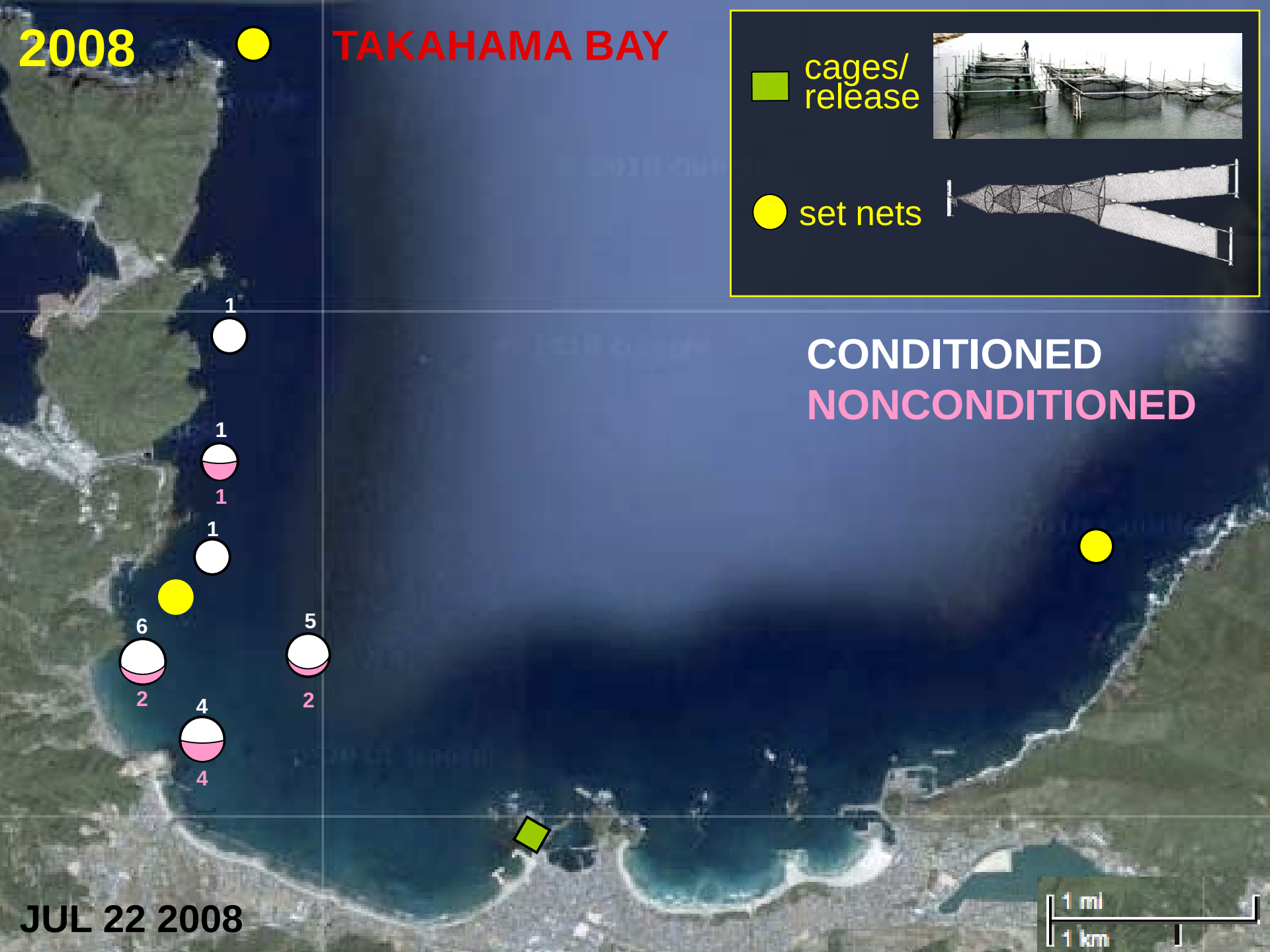
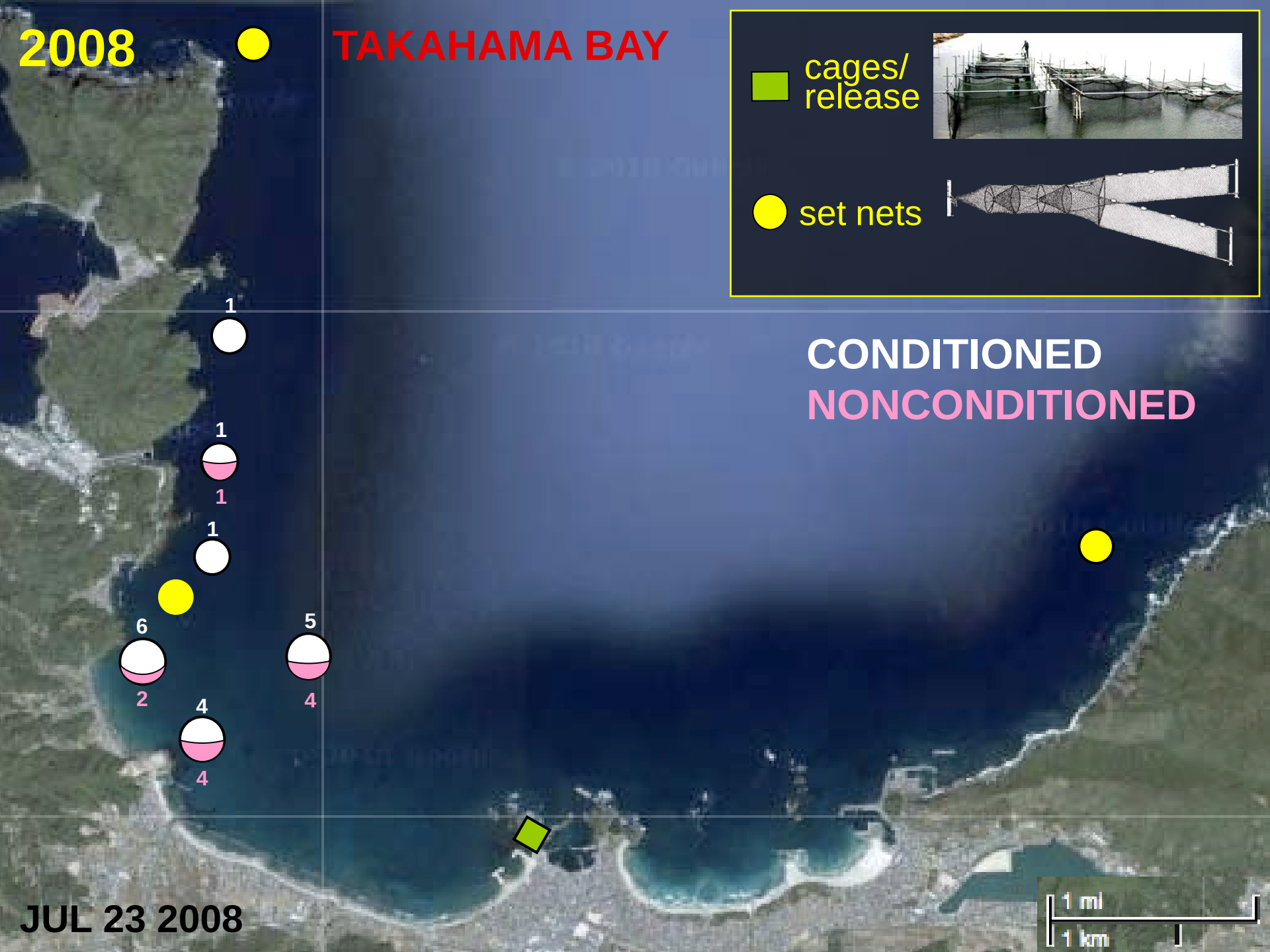
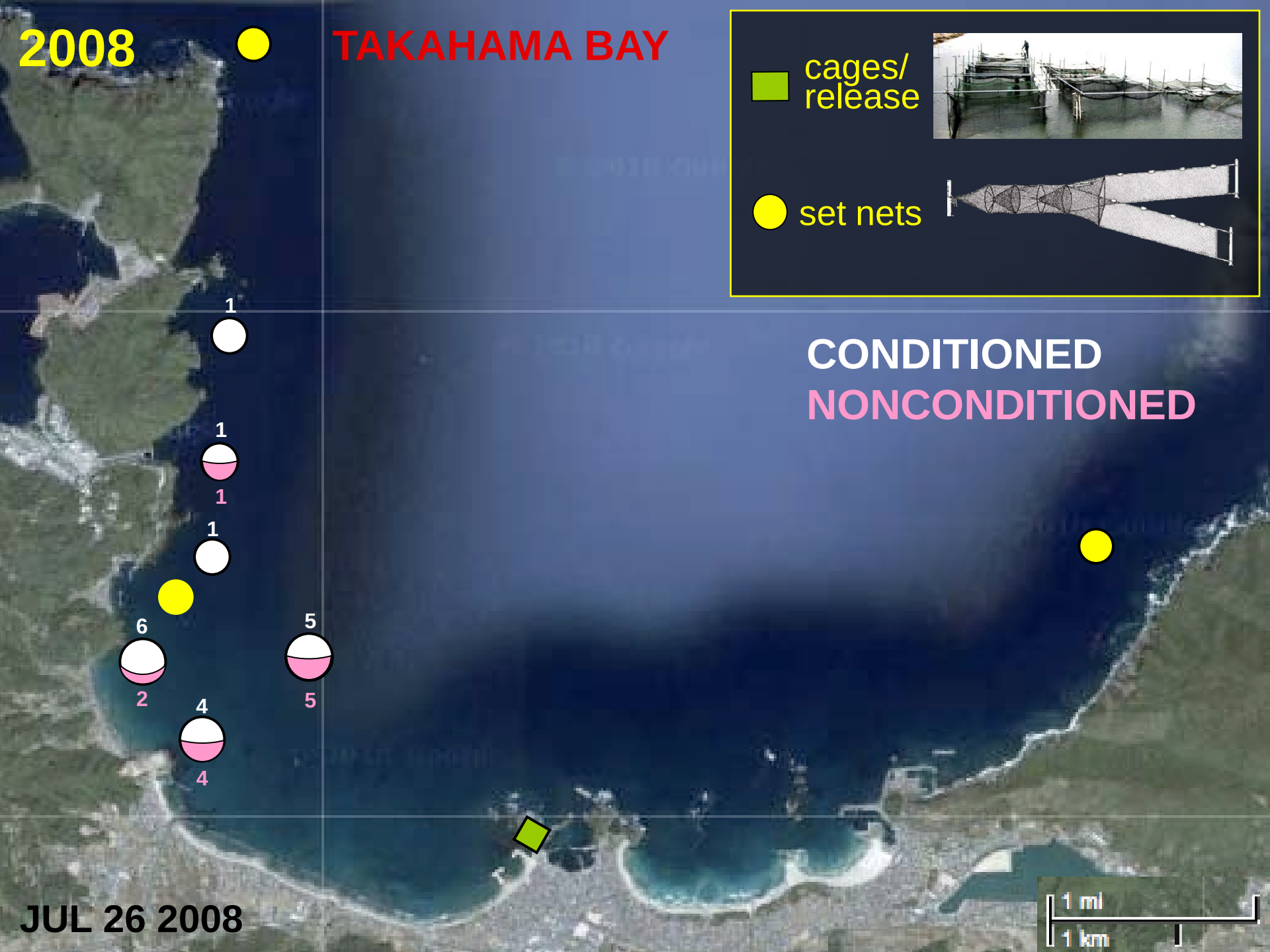
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
1
1
1
6
2
5
2
4
4
JUL 22 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
1
1
1
6
2
5
4
4
4
JUL 23 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
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NONCONDITIONED
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1
1
6
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5
4
4
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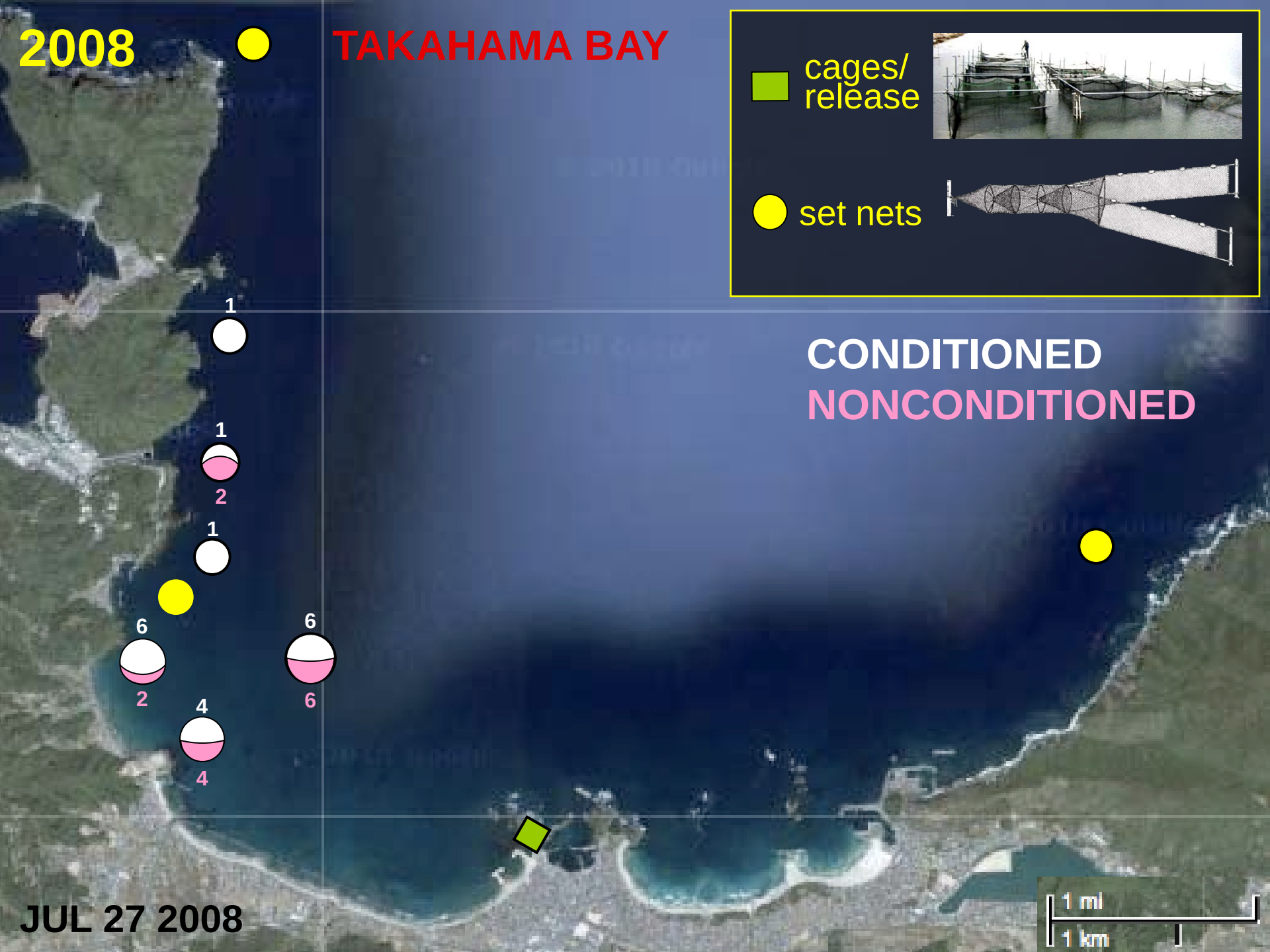
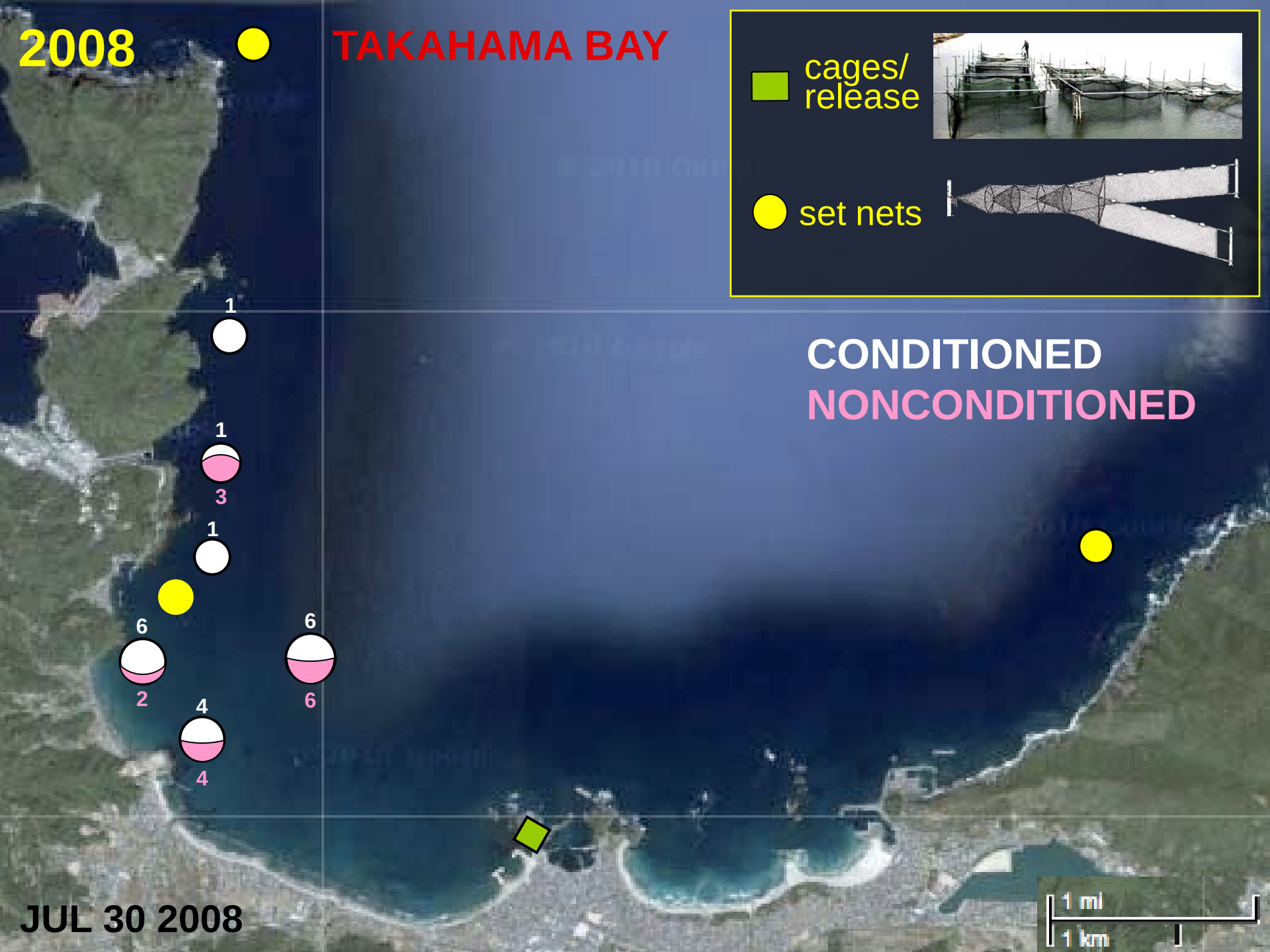
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
1
2
1
6
2
6
6
4
4
JUL 27 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
1
3
1
6
2
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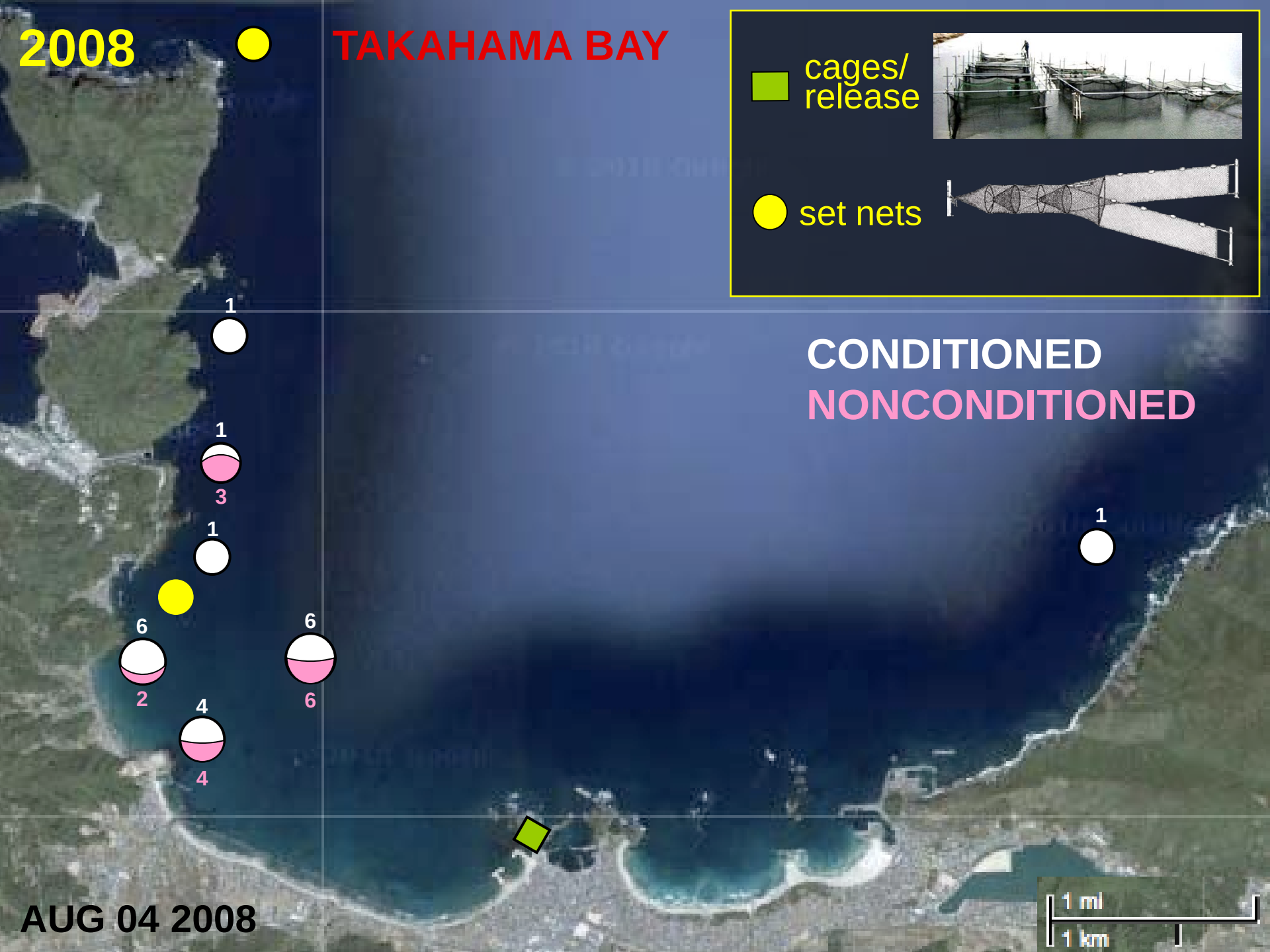
6
4
4
JUL 30 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
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1
3
1
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4
4
1
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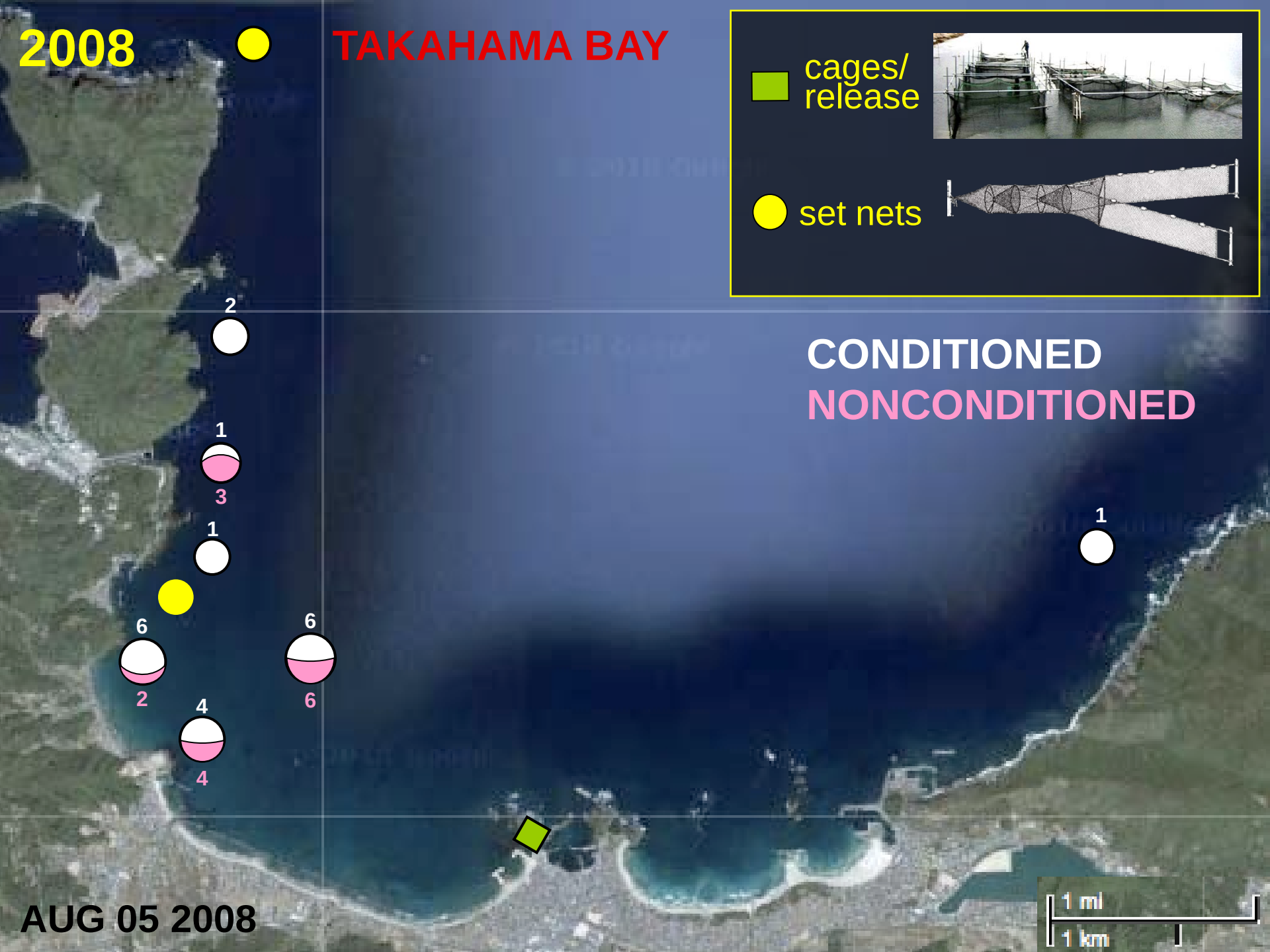
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
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1
3
1
6
2
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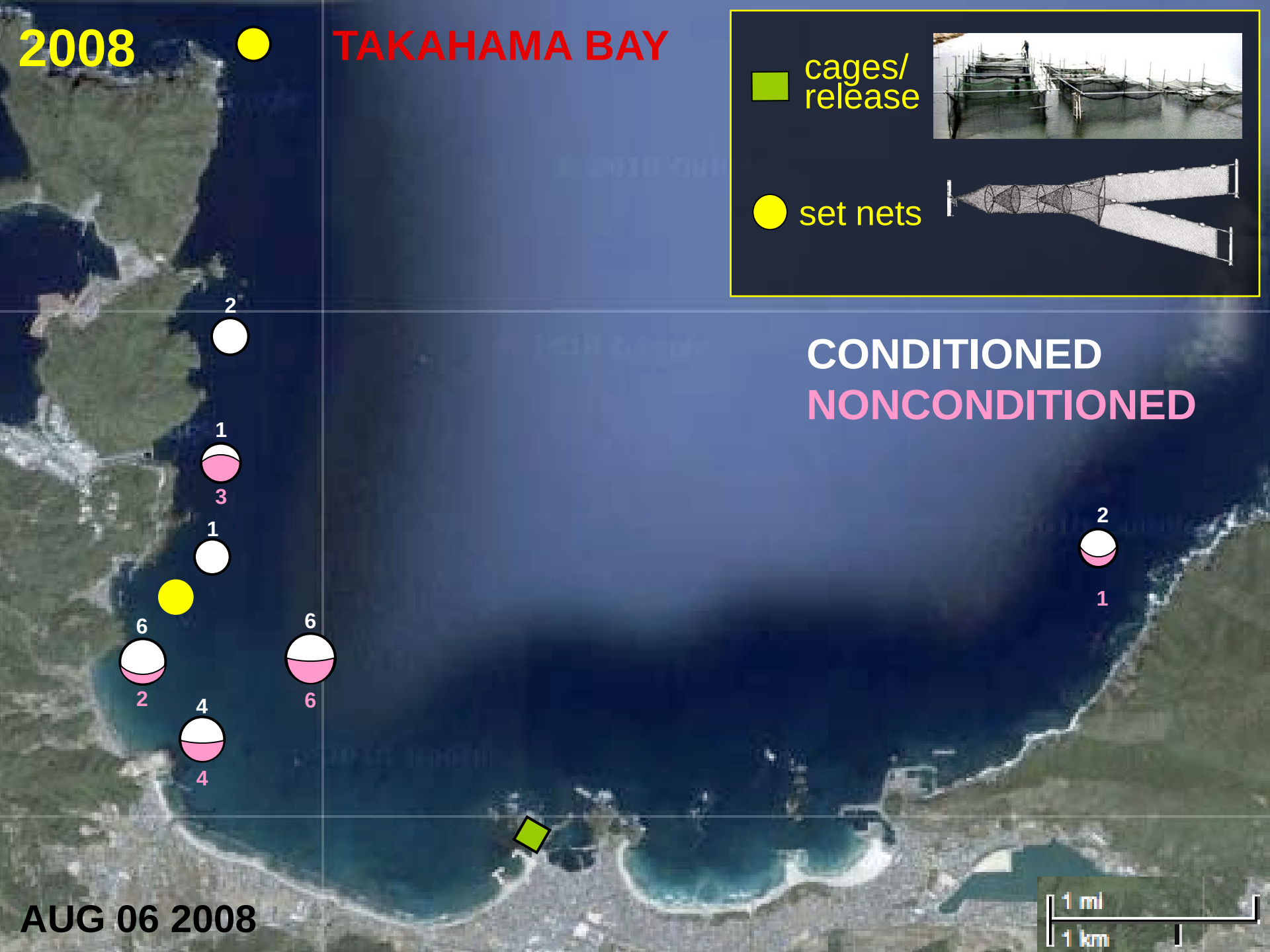
6
4
4
1
AUG 05 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
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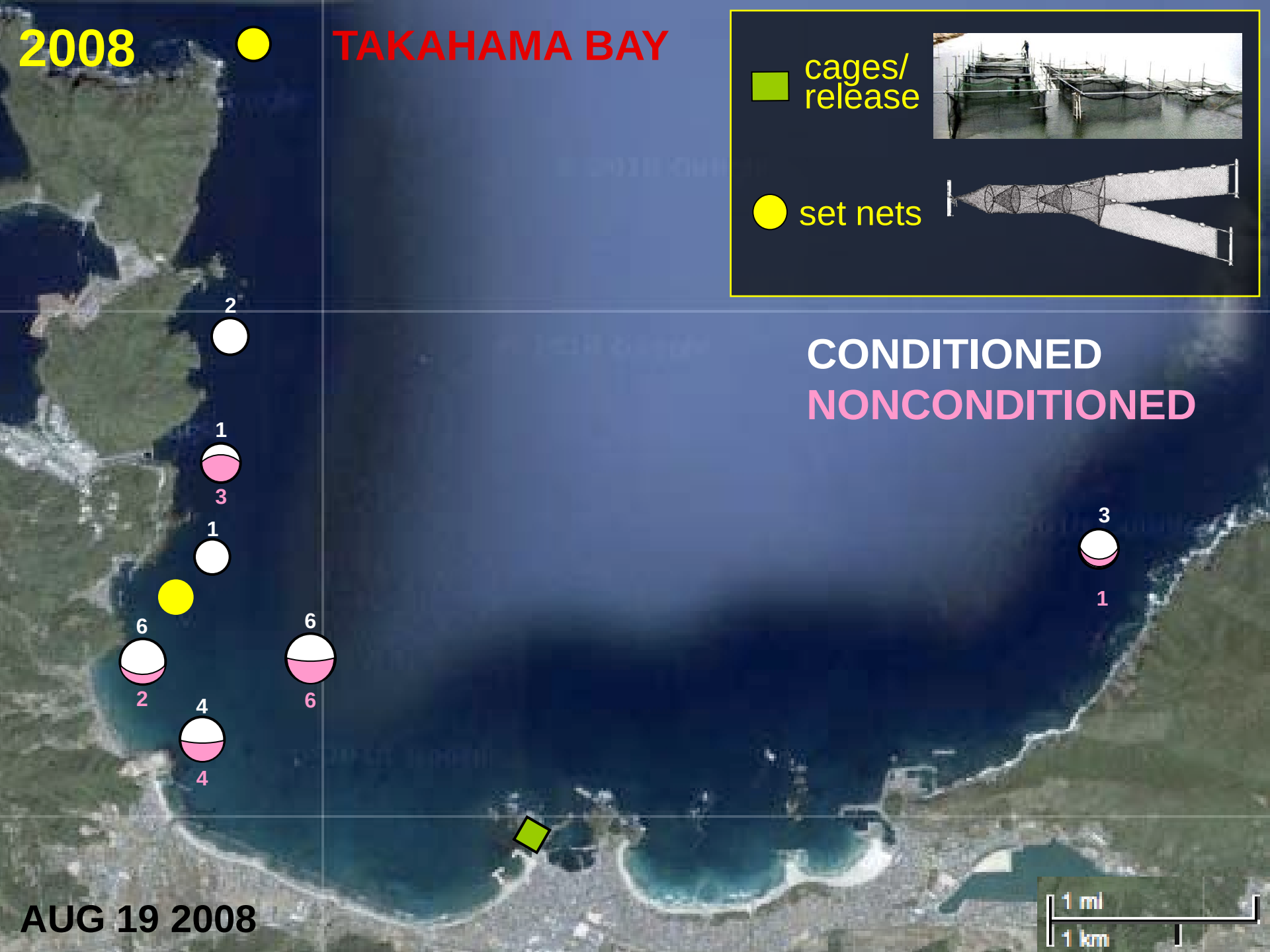
4
2
1
AUG 06 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
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1
3
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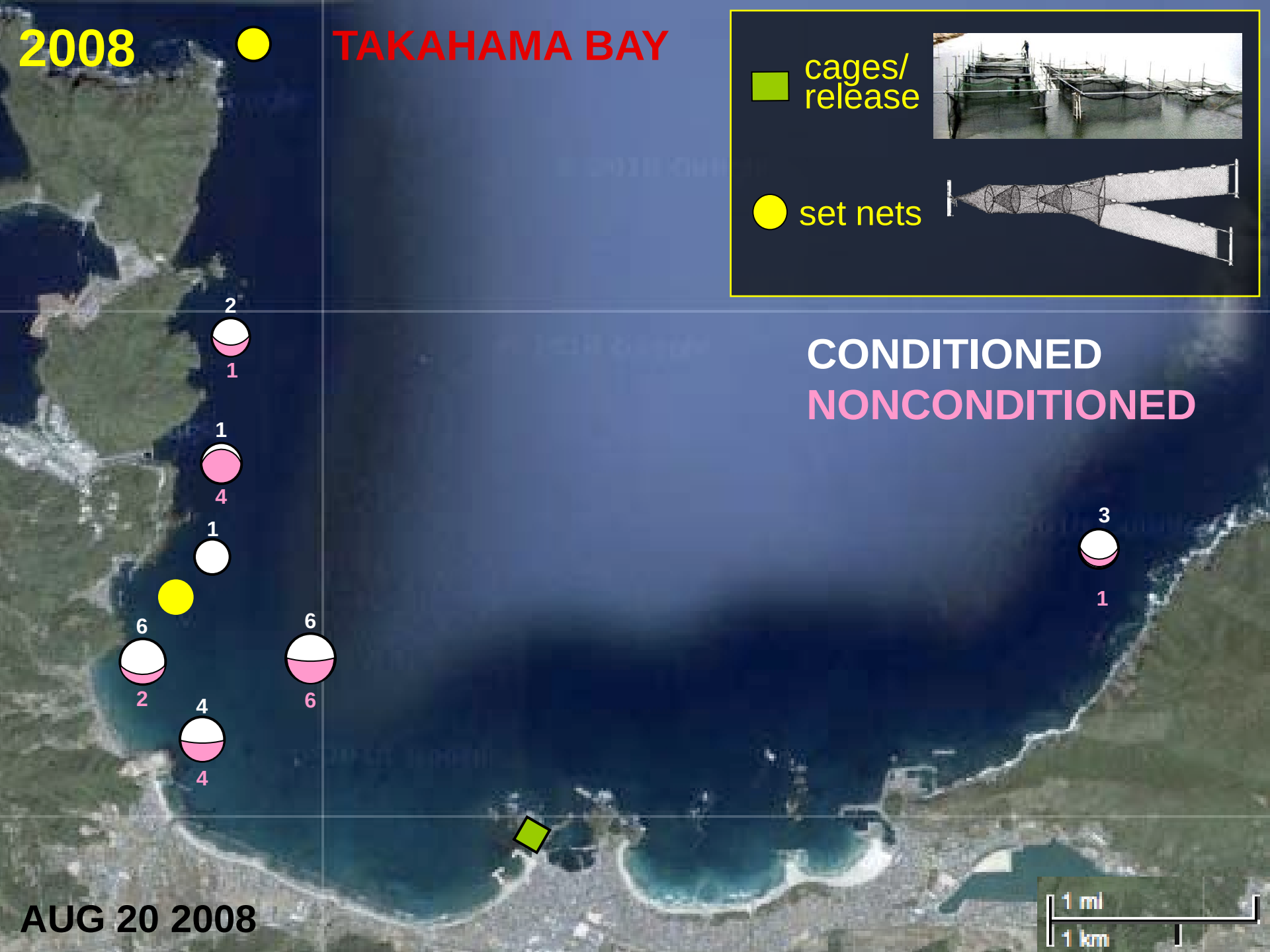
4
4
3
1
AUG 19 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
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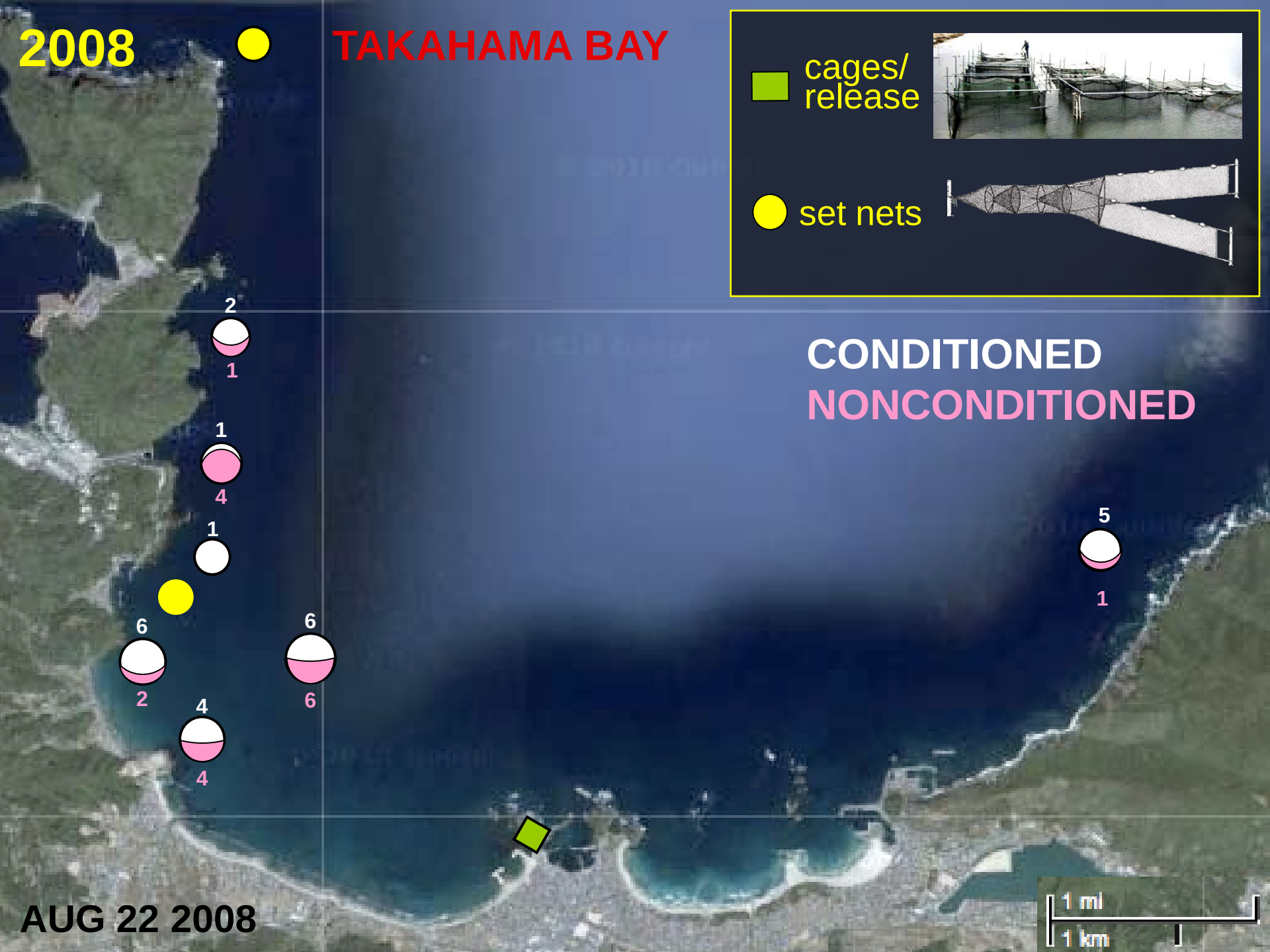
4
4
3
1
AUG 20 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
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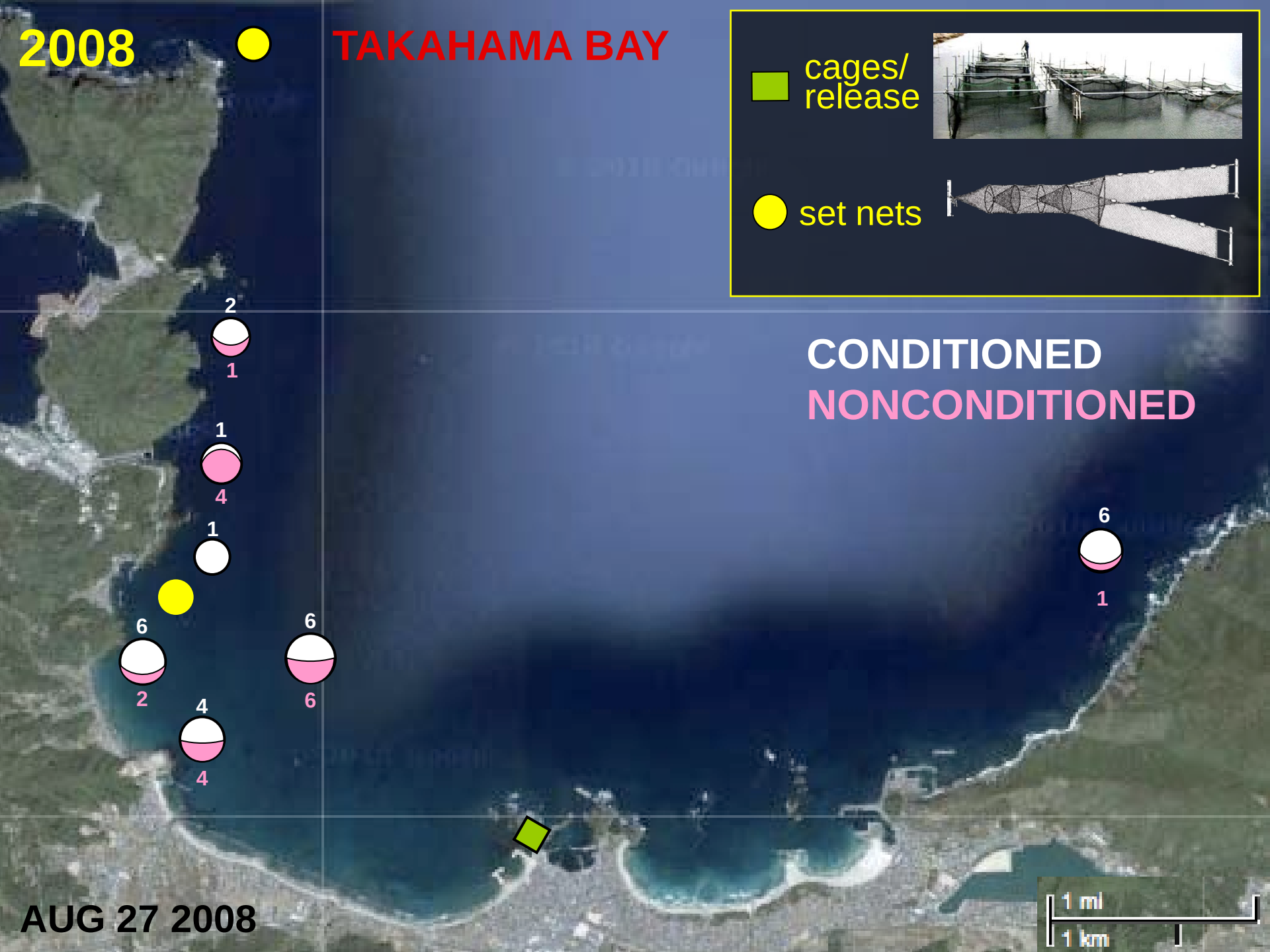
AUG 22 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
2
1
1
4
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6
2
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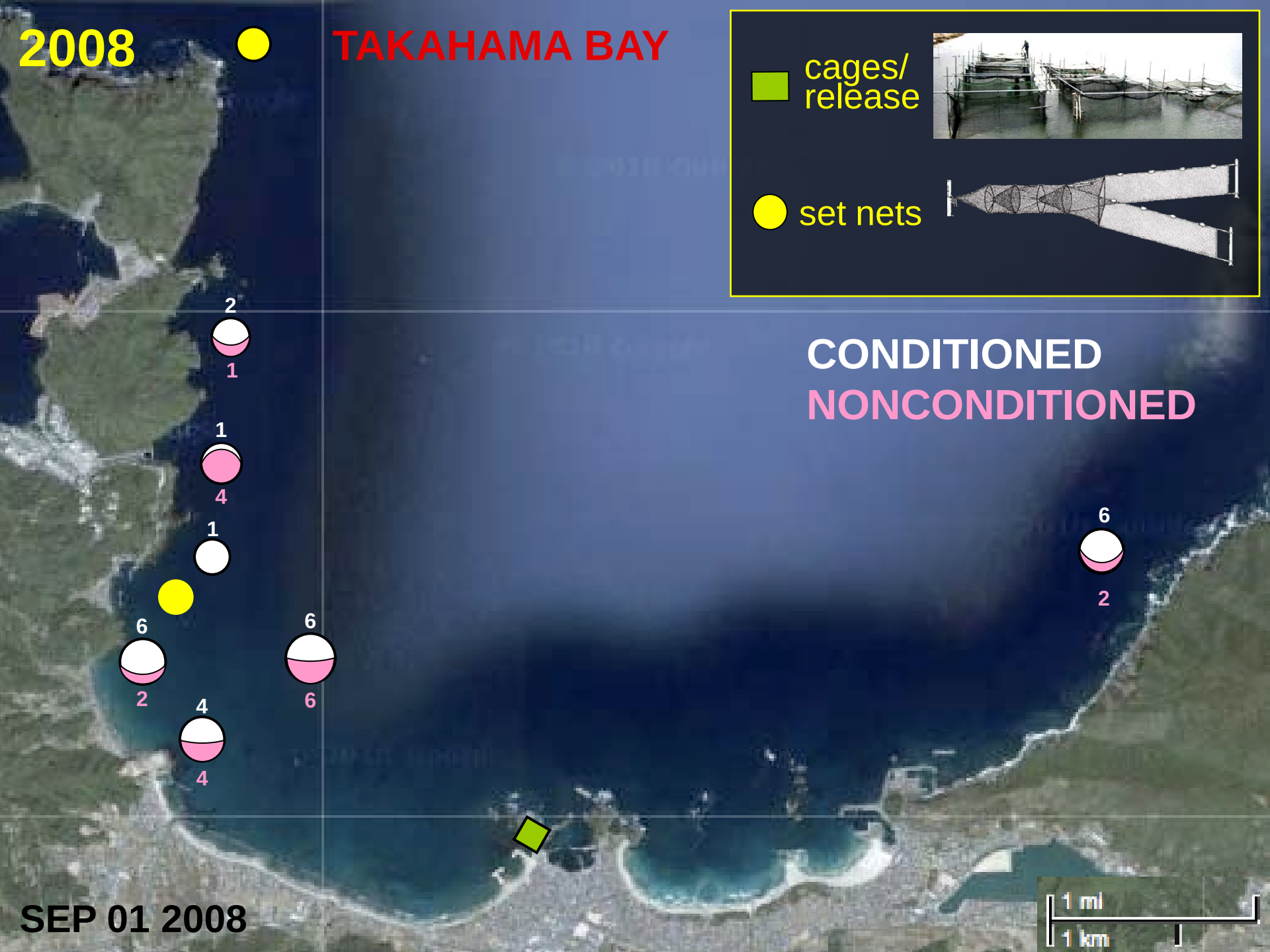
4
4
6
1
AUG 27 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
2
1
1
4
1
6
2
6
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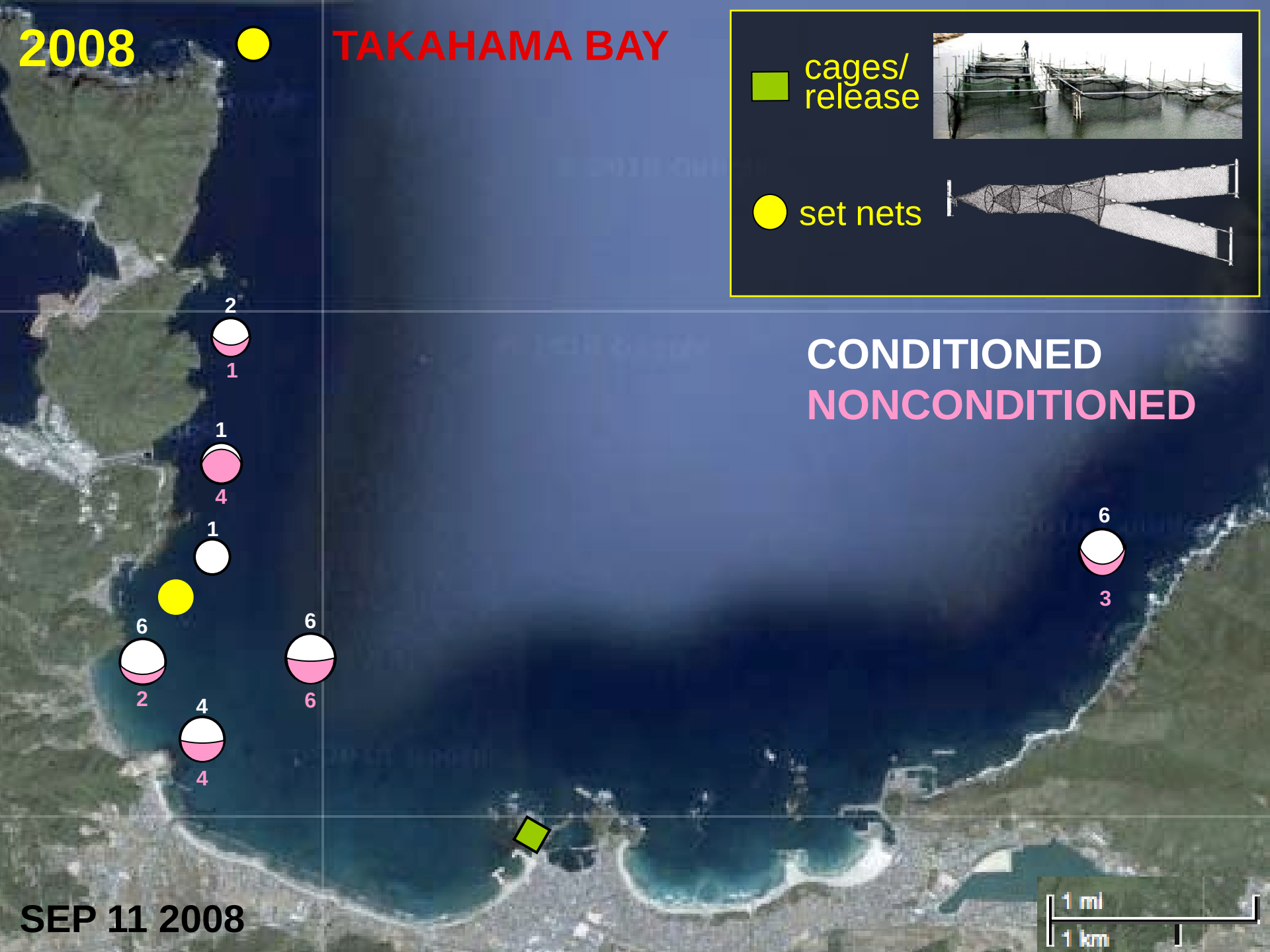
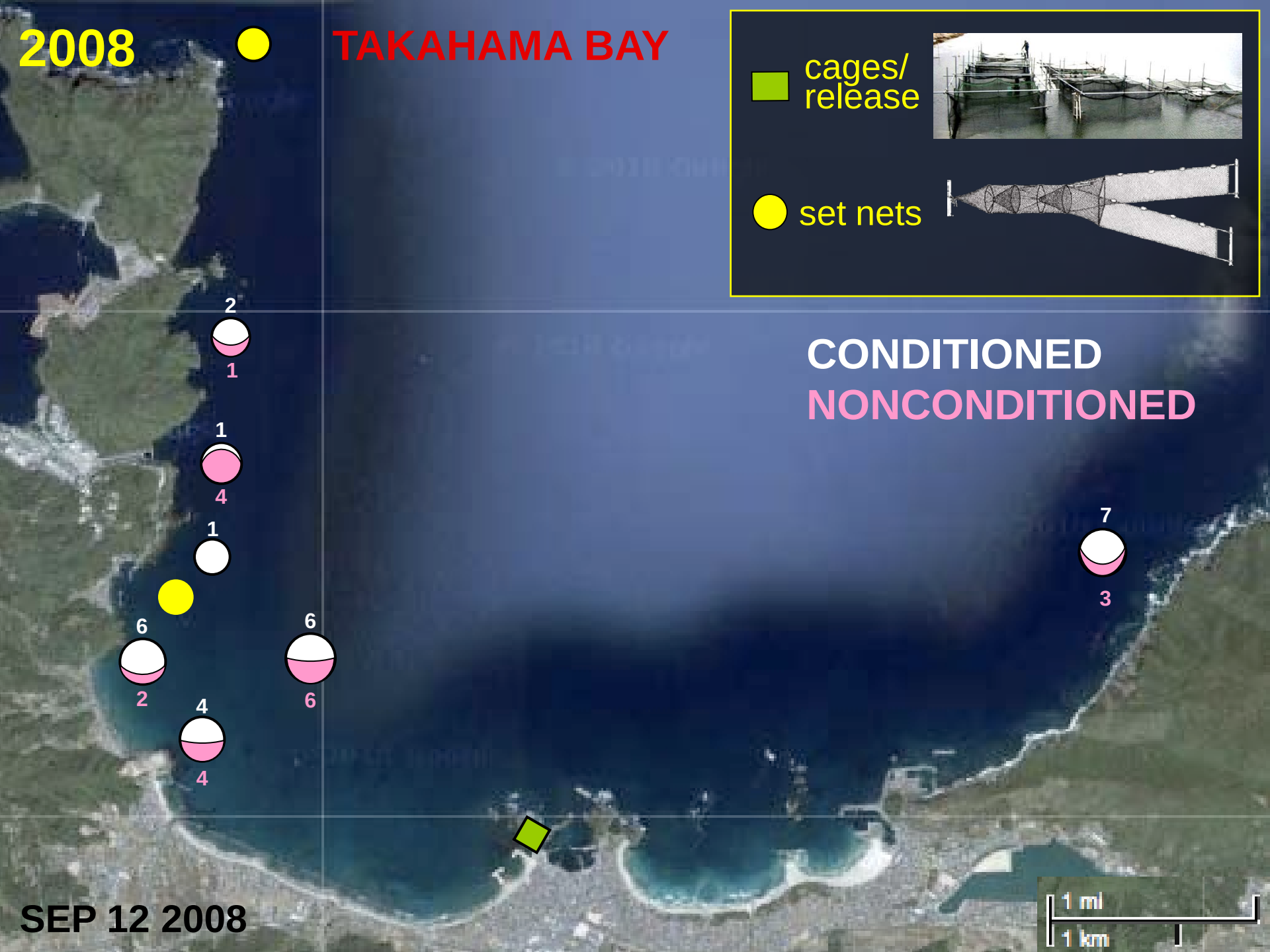
4
4
6
2
SEP 01 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
2
1
1
4
1
6
2
6
6
4
4
6
3
SEP 11 2008
1 mi
1 km


2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
2
1
1
4
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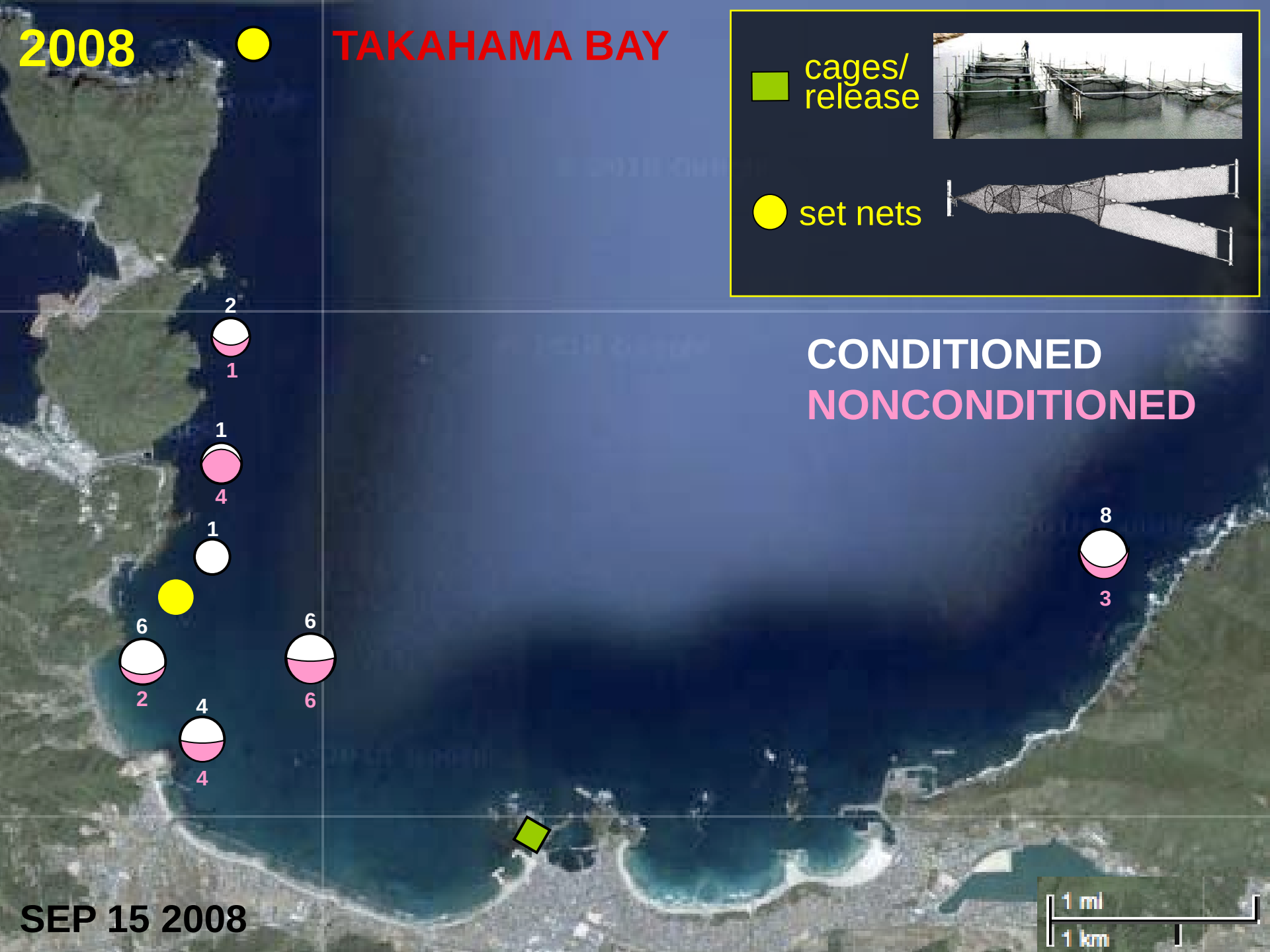
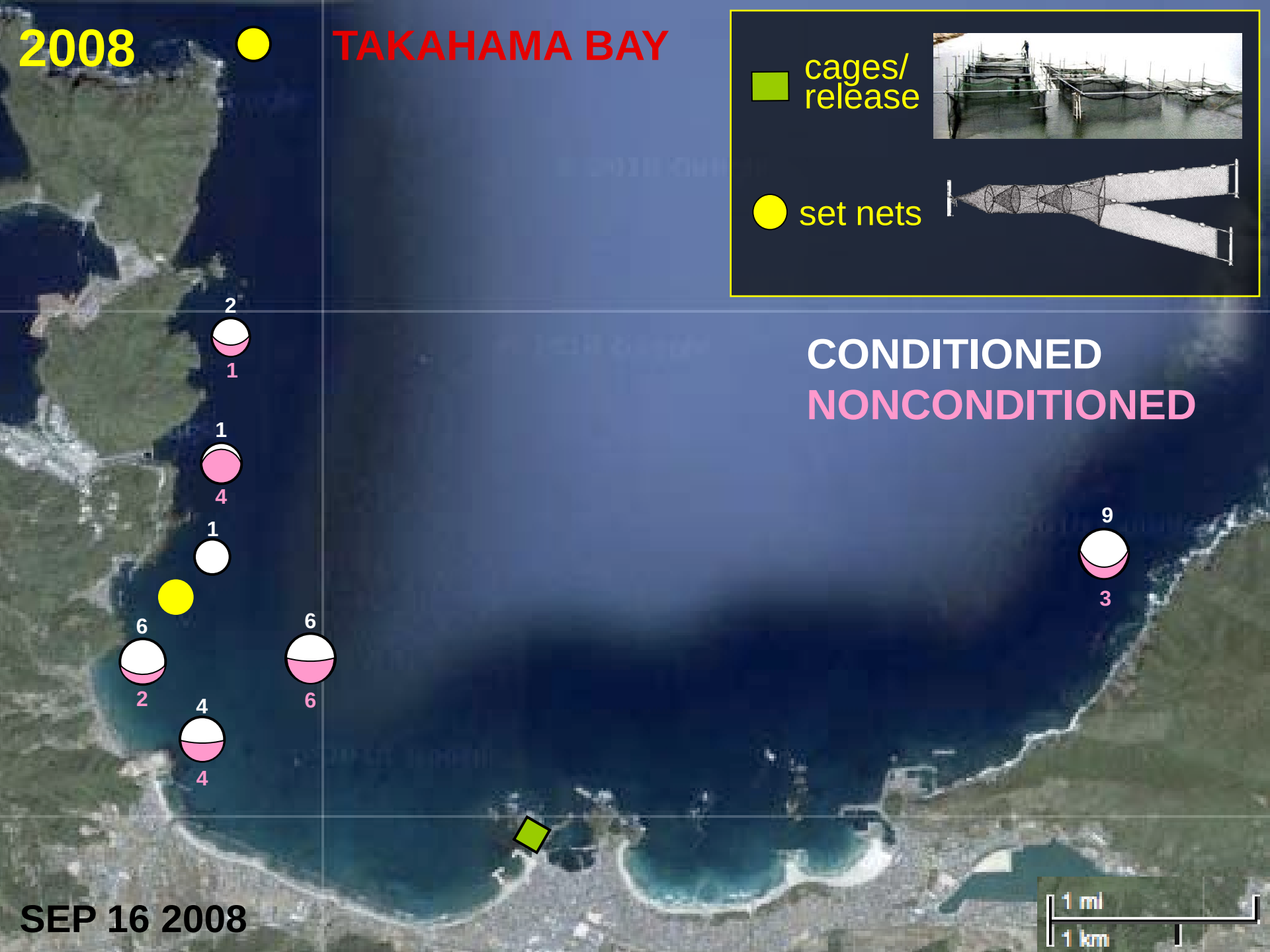
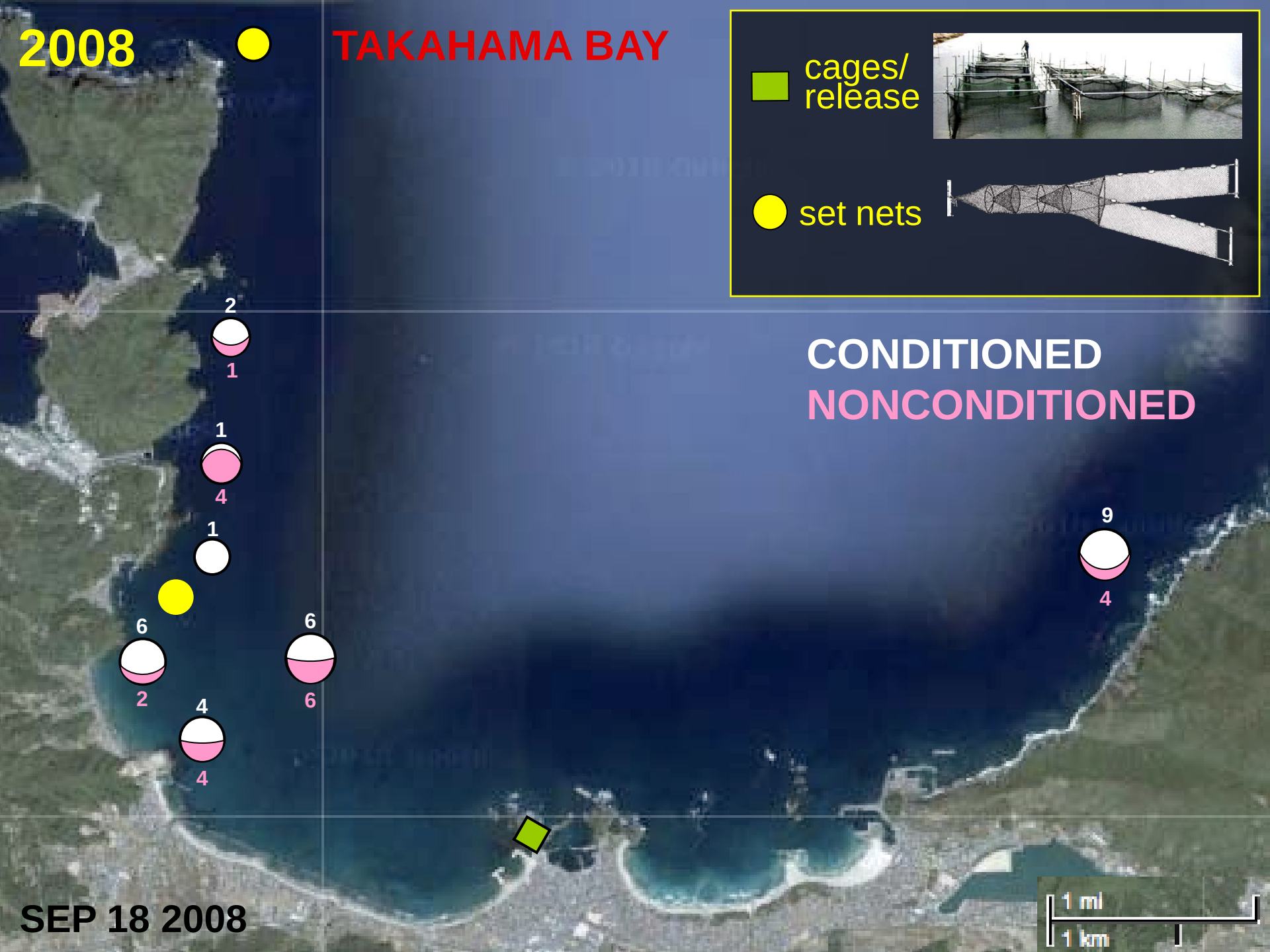
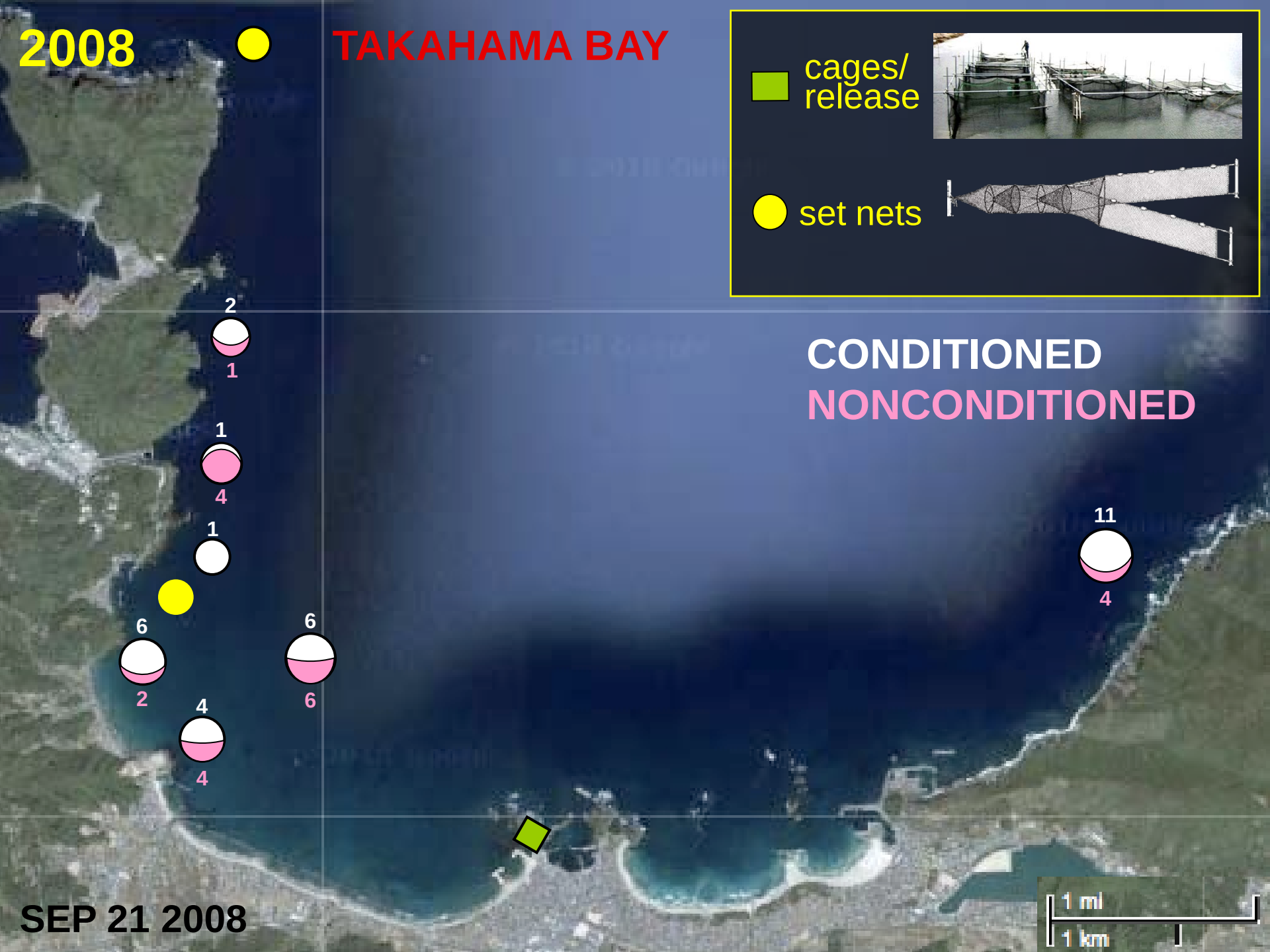
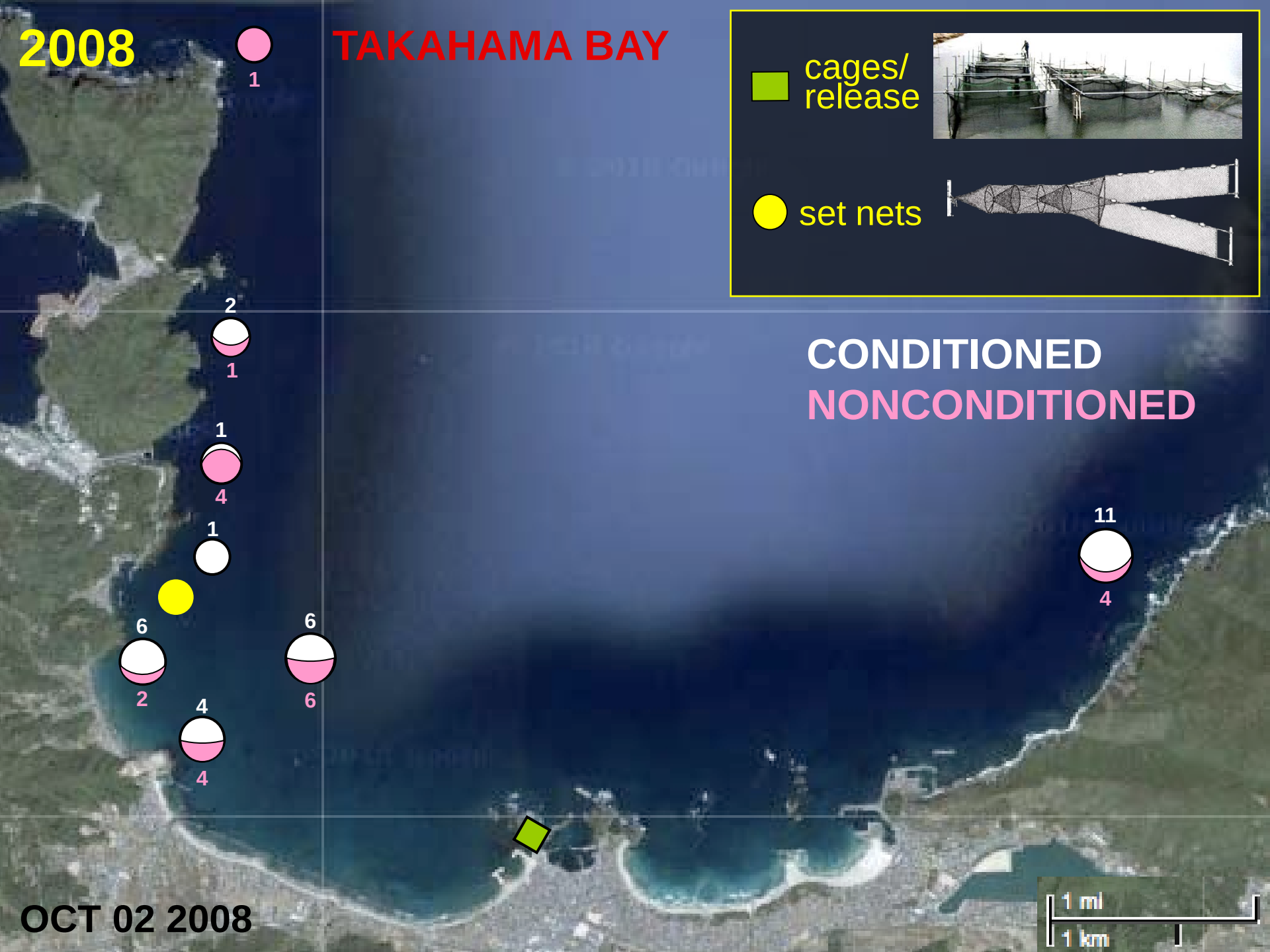
6
2
6
6
4
4
7
3
SEP 12 2008
1 mi
1 km

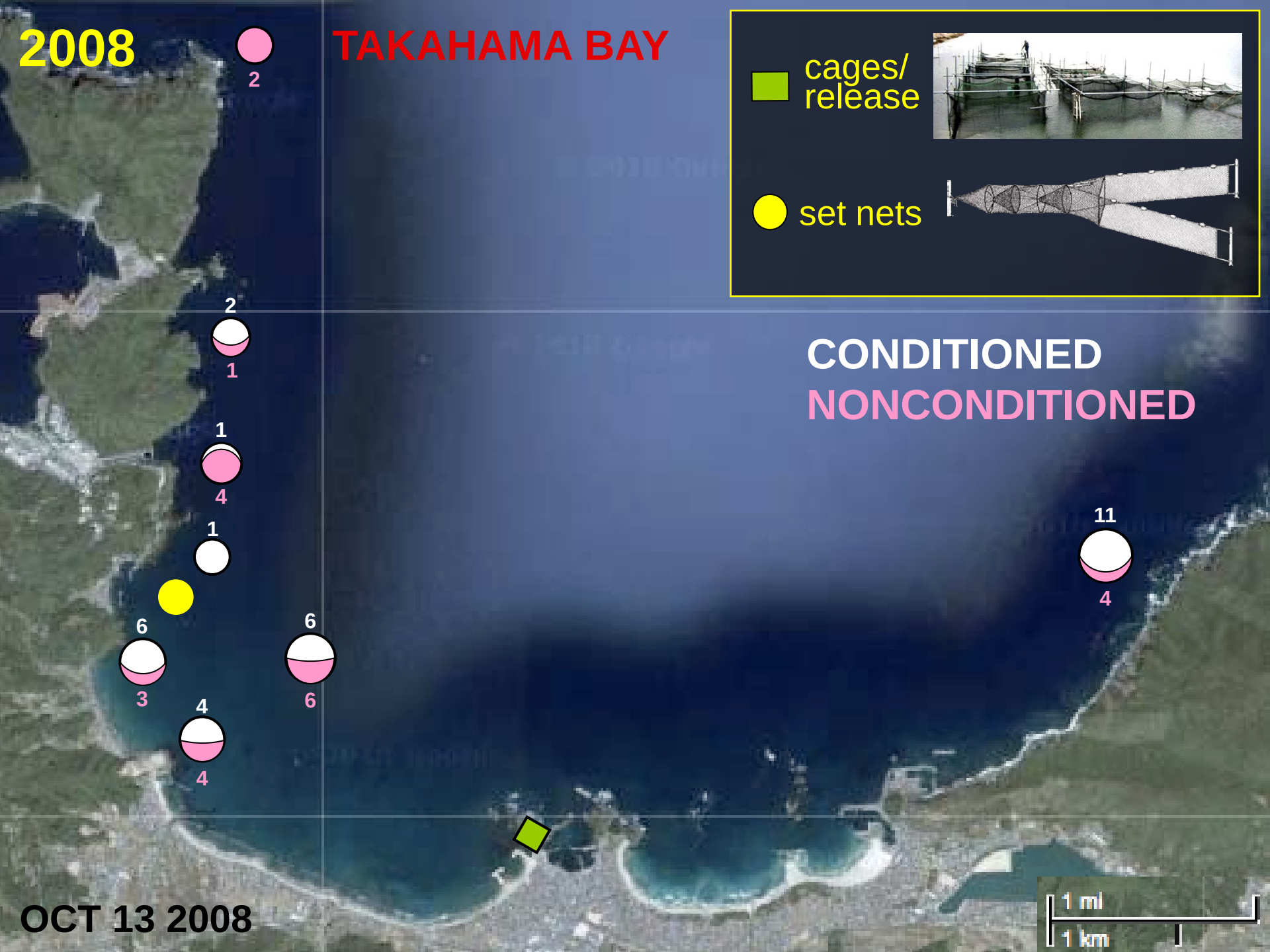

2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
2
1
1
4
1
6
2
6
6
4
4
8
3
SEP 15 2008
1 mi
1 km

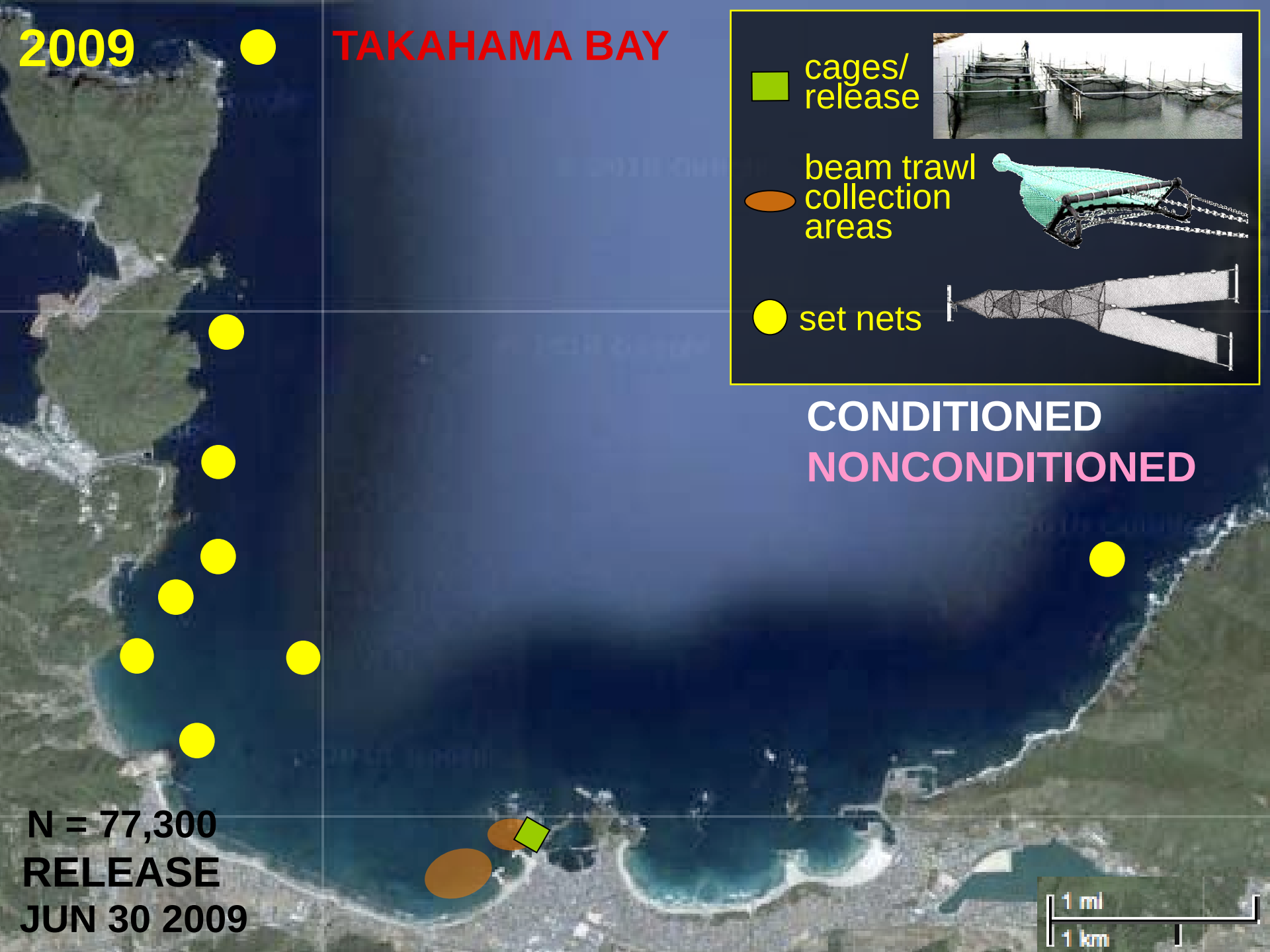

2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
2
1
1
4
1
6
2
6
6
4
4
9
3
SEP 16 2008
1 mi
1 km

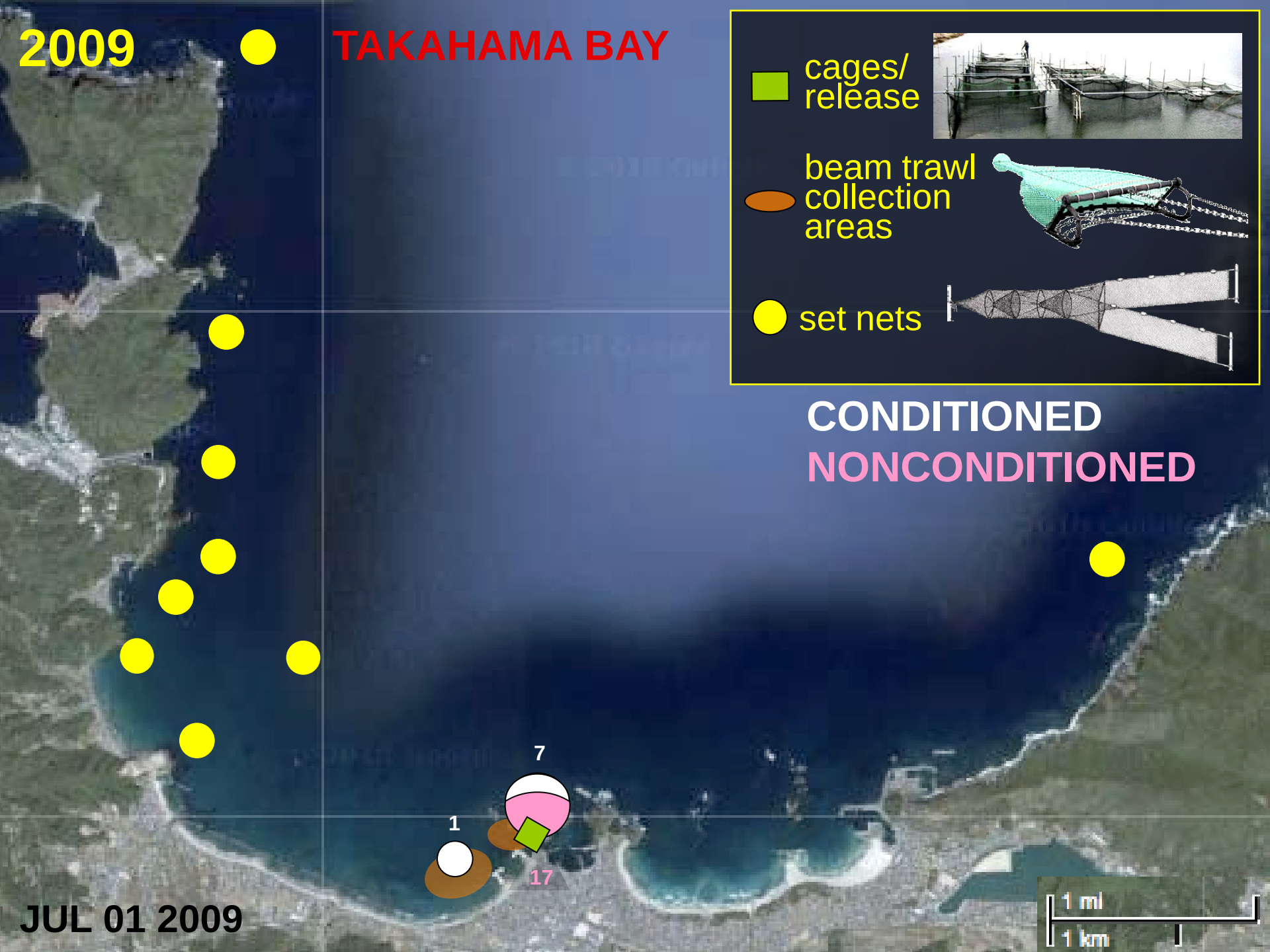

2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
2
1
1
4
1
6
2
6
6
4
4
9
4
SEP 18 2008
1 mi
1 km

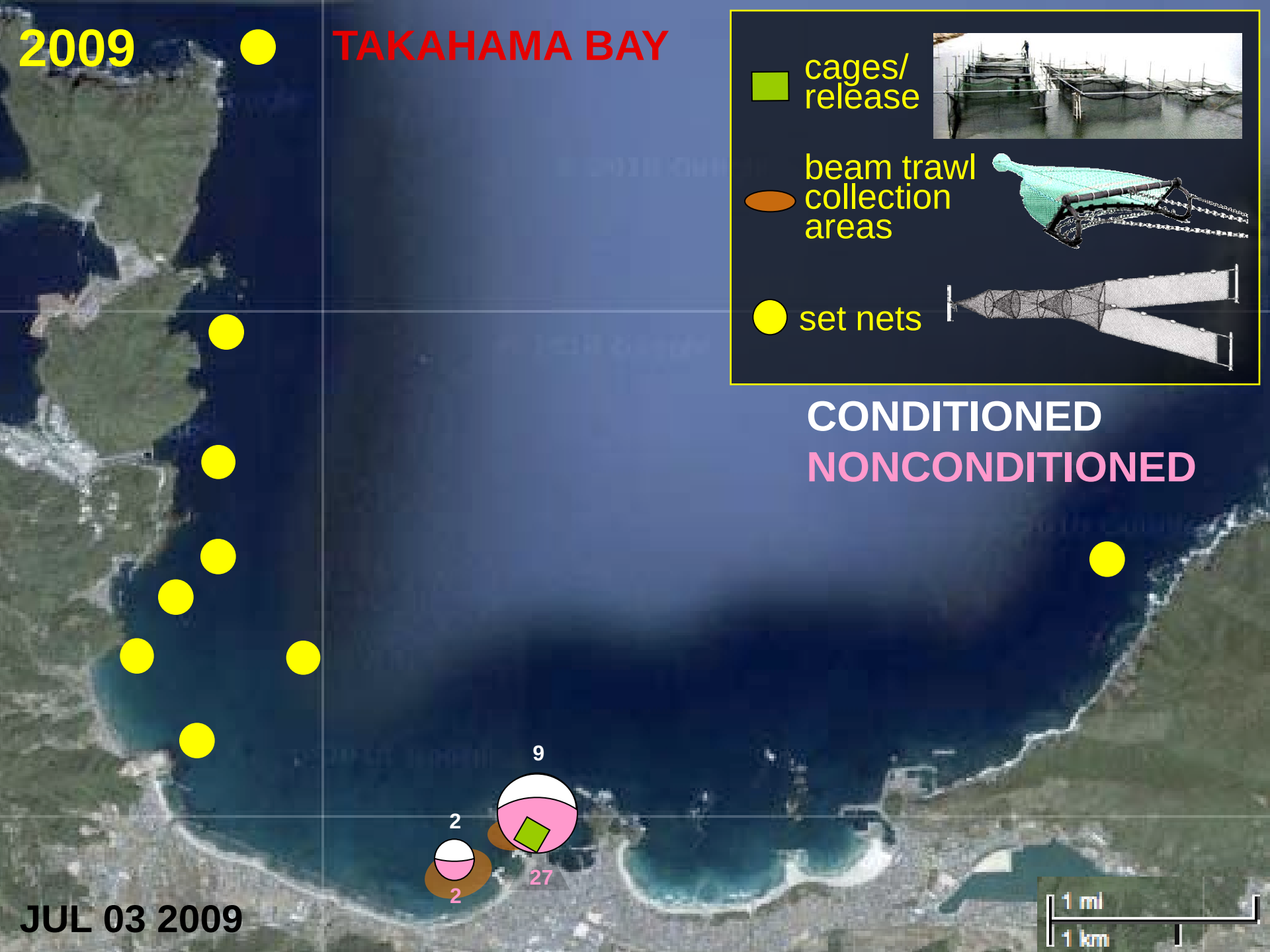

2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
2
1
1
4
1
6
2
6
6
4
4
11
4
SEP 21 2008
1 mi
1 km

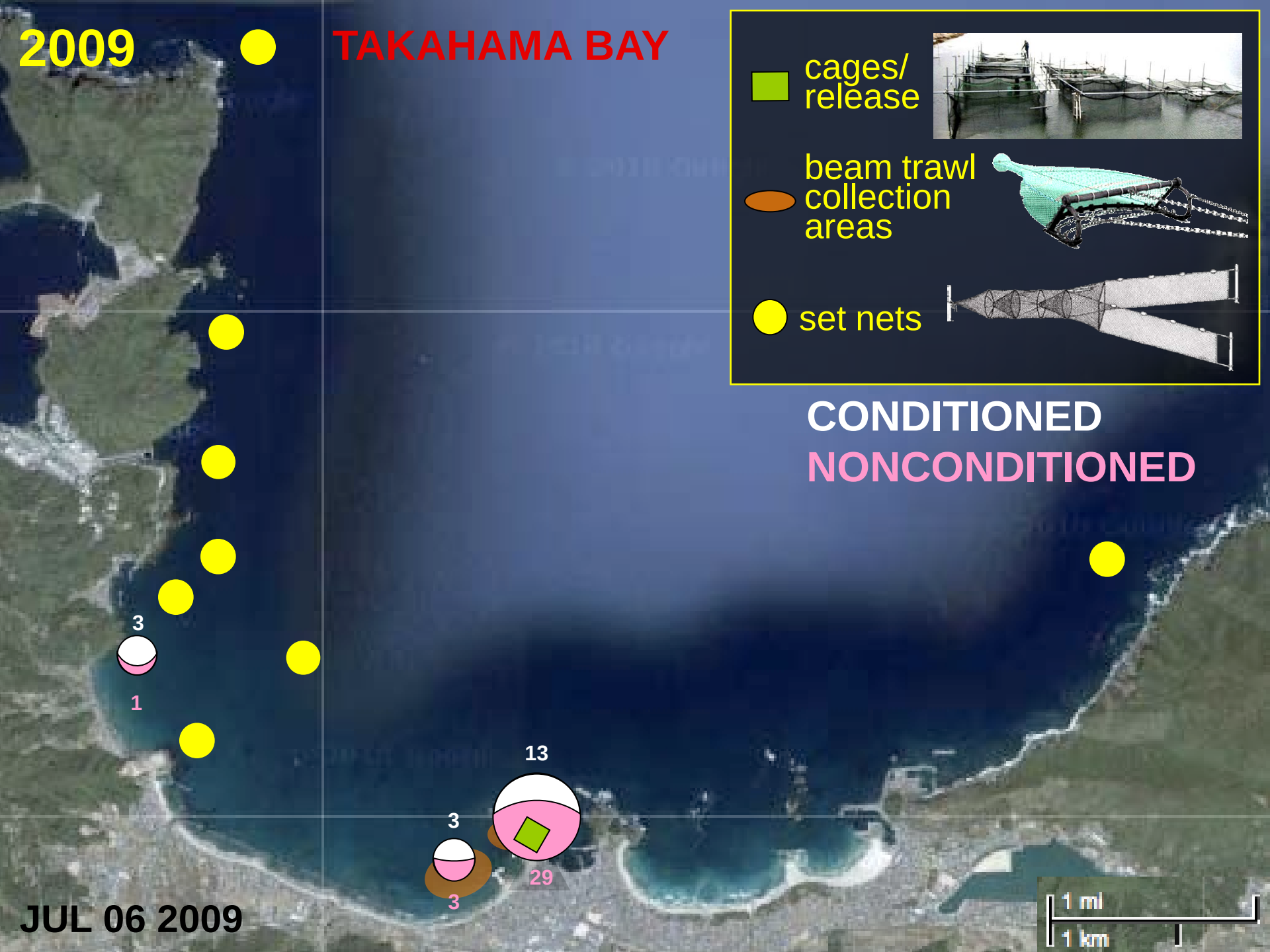

2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
1
2
1
1
4
1
6
2
6
6
4
4
11
4
OCT 02 2008
1 mi
1 km

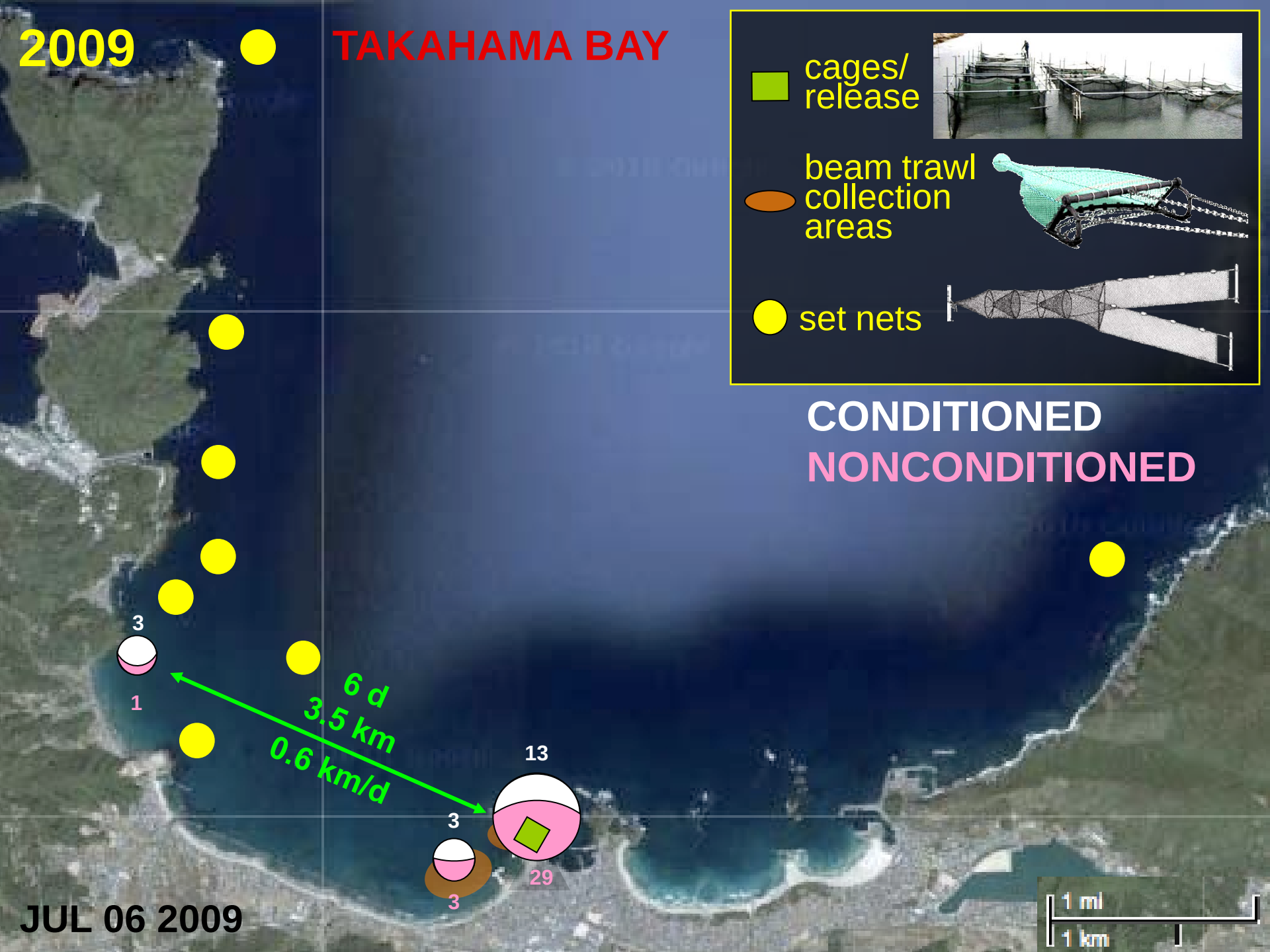

2008
TAKAHAMA BAY
cages/ release
set nets
CONDITIONED
NONCONDITIONED
2
2
1
1
4
1
6
3
6
6
4
4
11
4
OCT 13 2008
1 mi
1 km

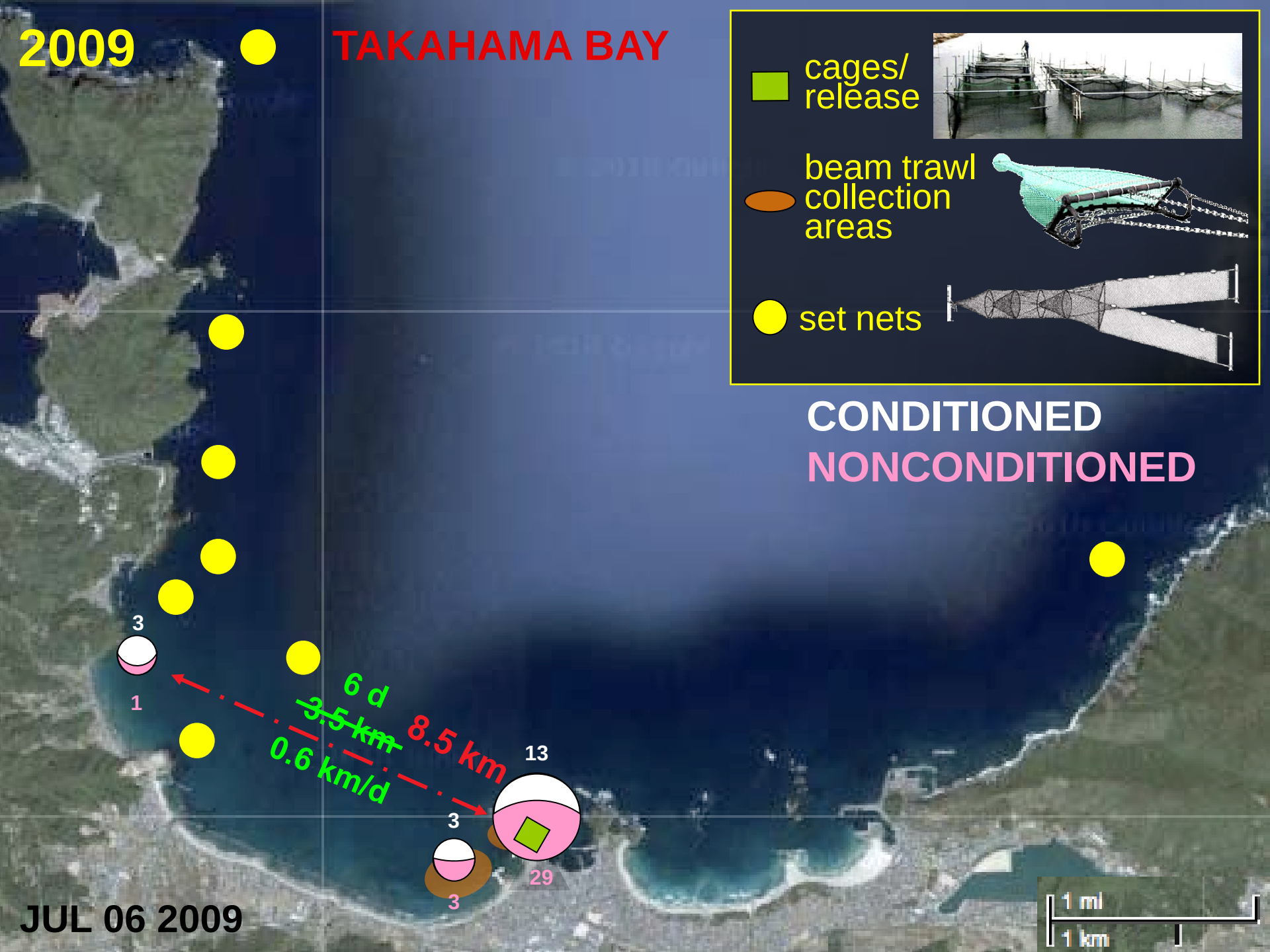

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
N = 77,300
RELEASE
JUN 30 2009
1 mi
1 km

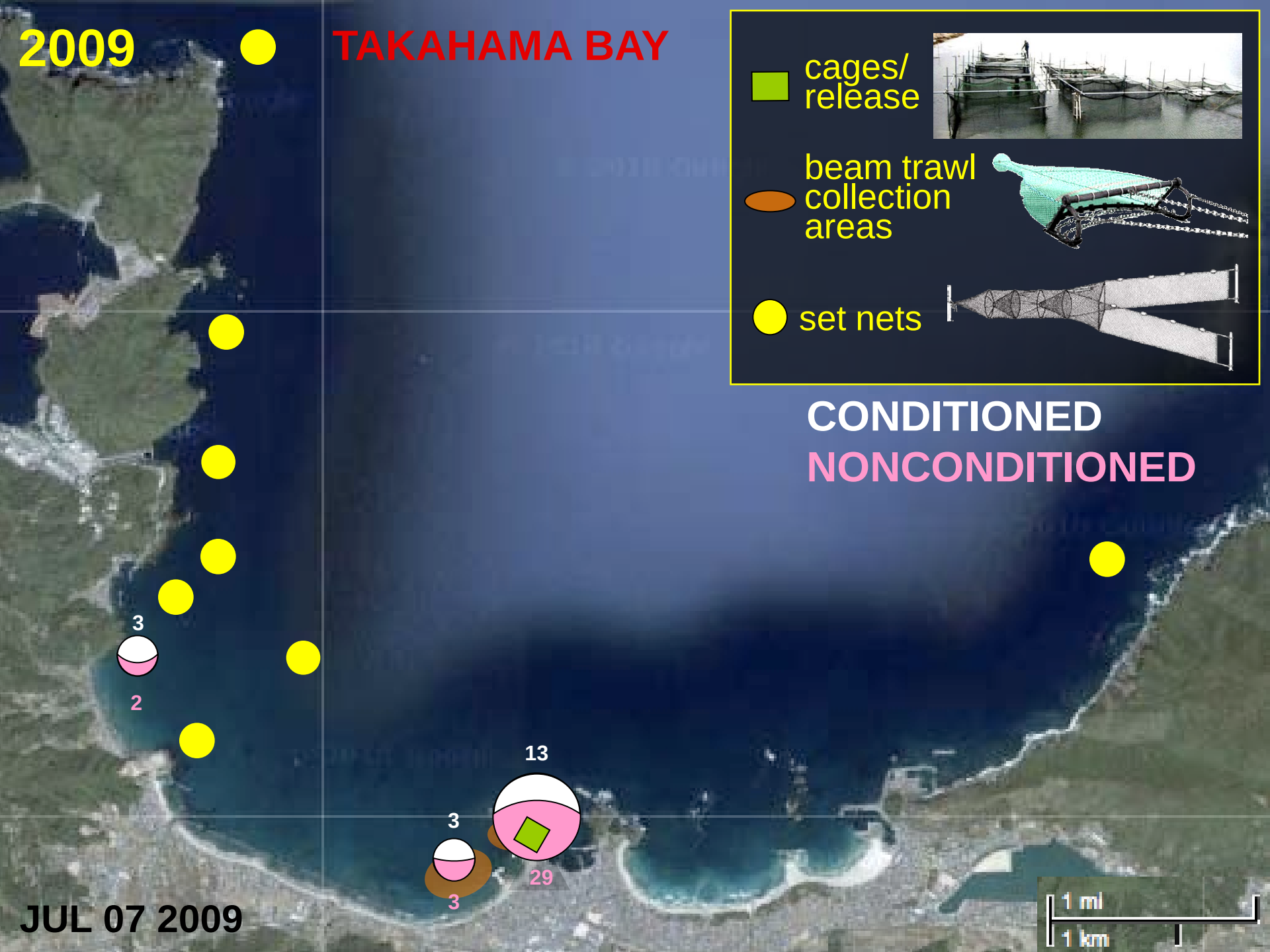

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
7
1
17
JUL 01 2009
1 mi
1 km

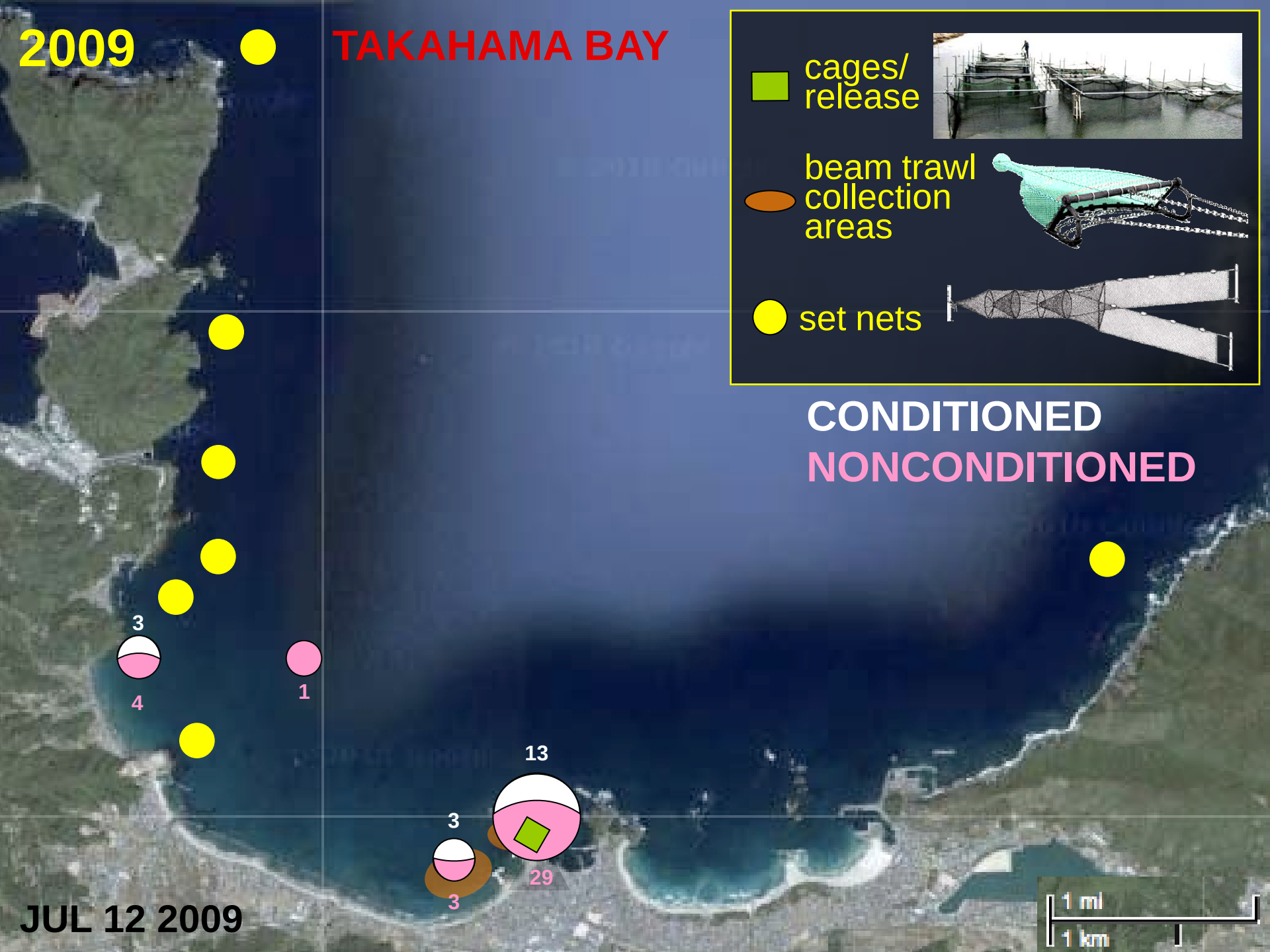

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
9
2
2
27
JUL 03 2009
1 mi
1 km

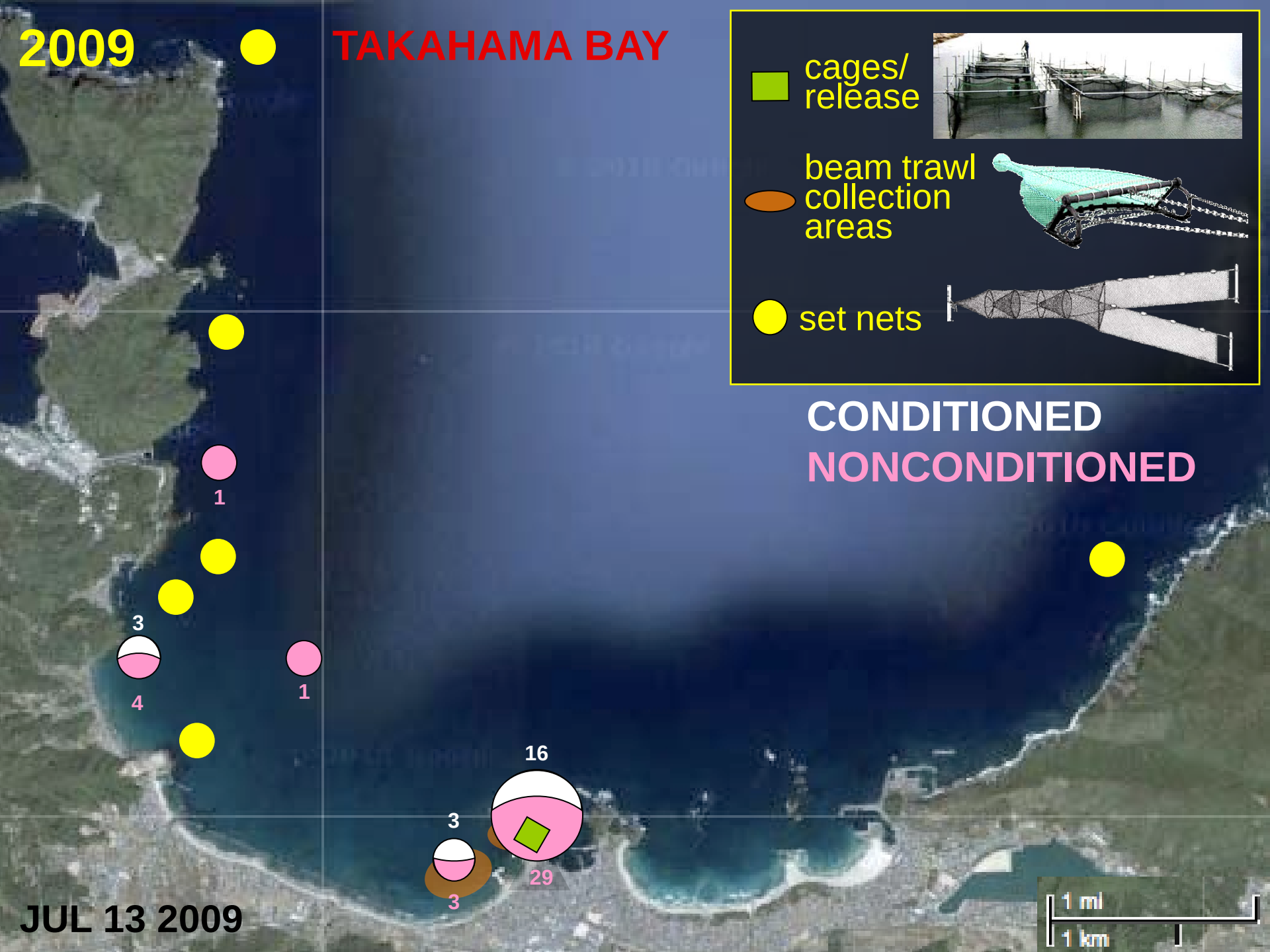

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
3
1
13
3
29
3
JUL 06 2009
1 mi
1 km

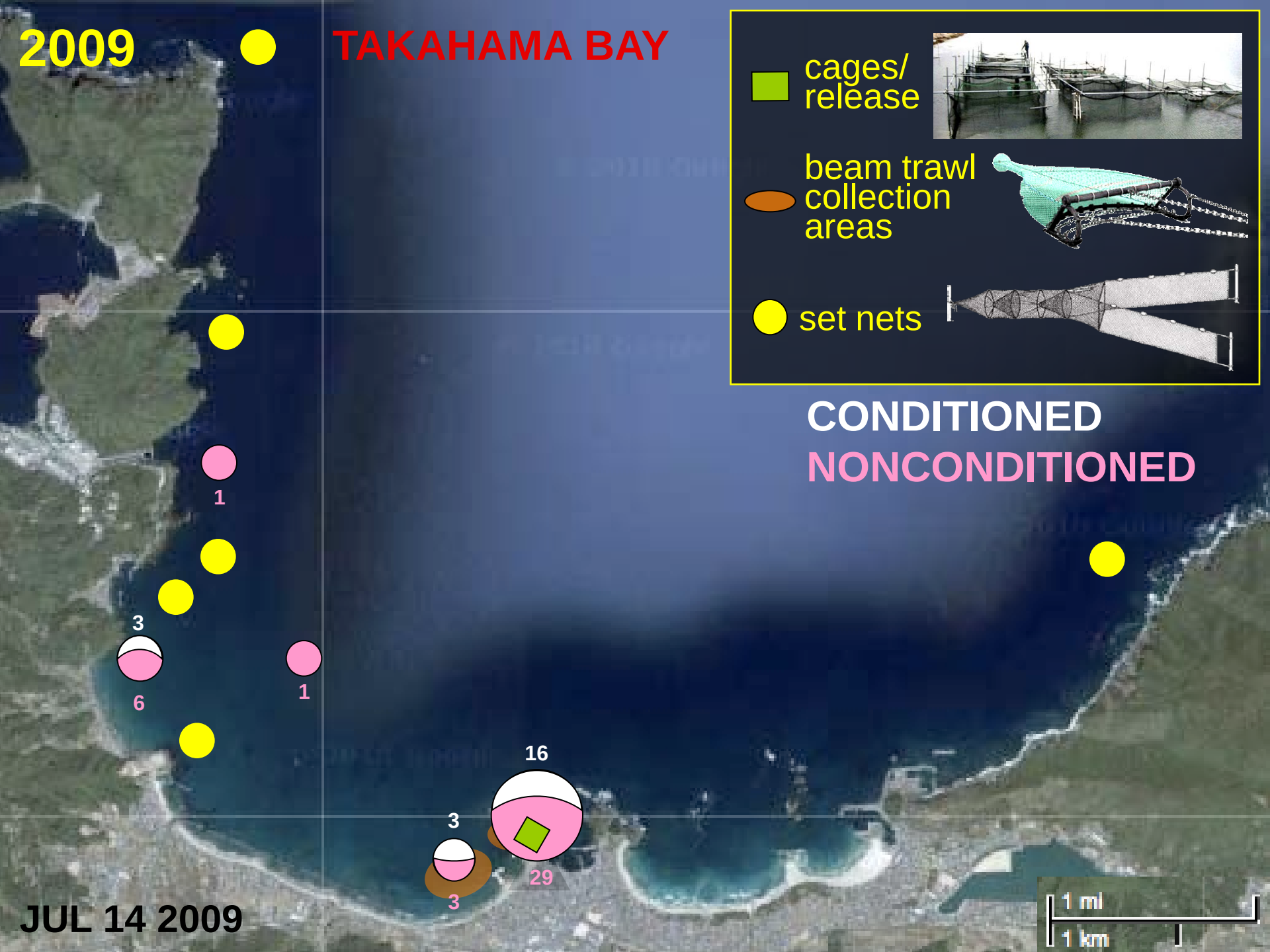

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
3
1
6 d
3.5 km
0.6 km/d
13
3
29
3
JUL 06 2009
1 mi
1 km

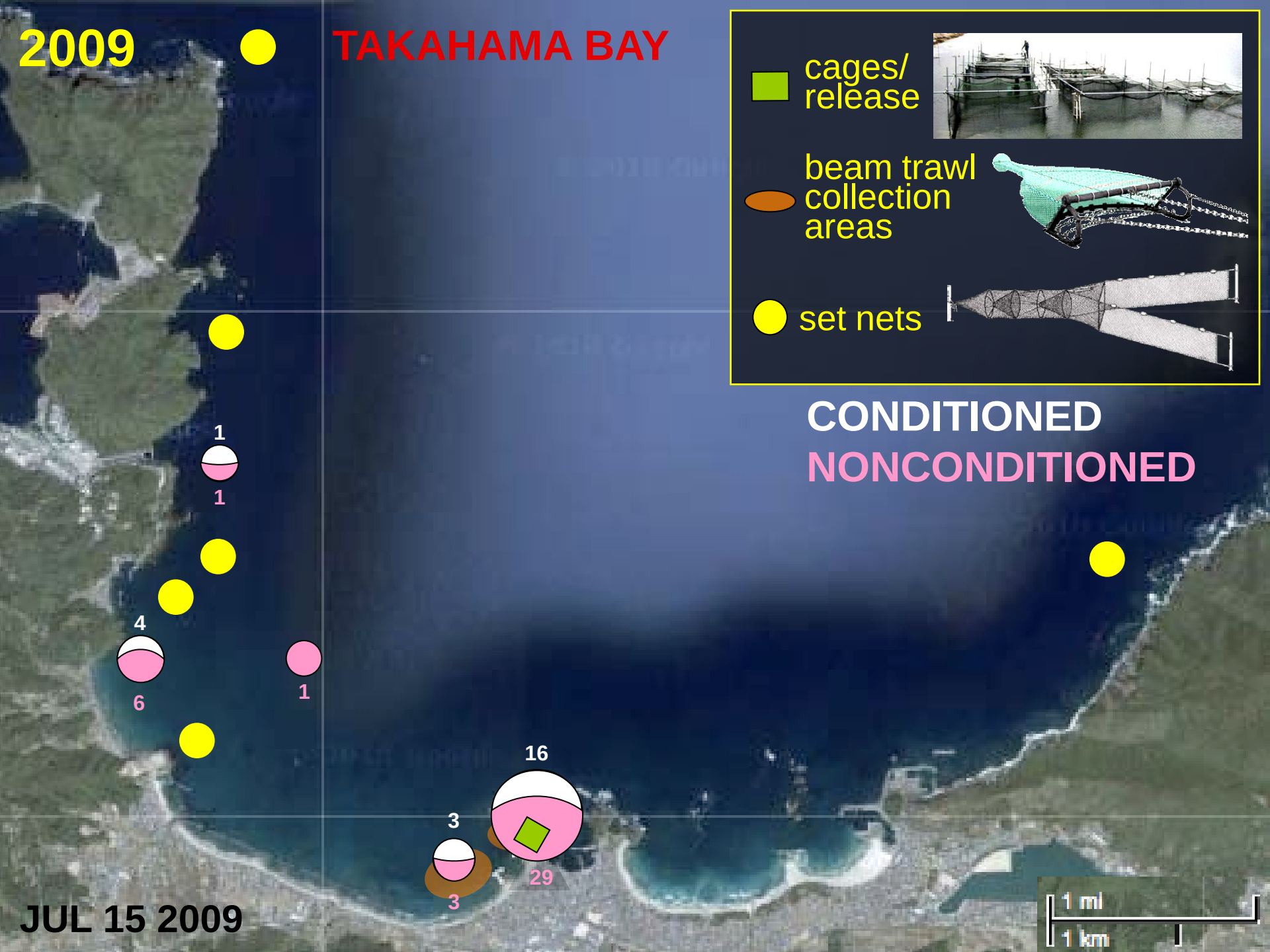

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
3
1
6 d
3.5 km
8.5 km
0.6 km/d
13
3
29
3
JUL 06 2009
1 mi
1 km

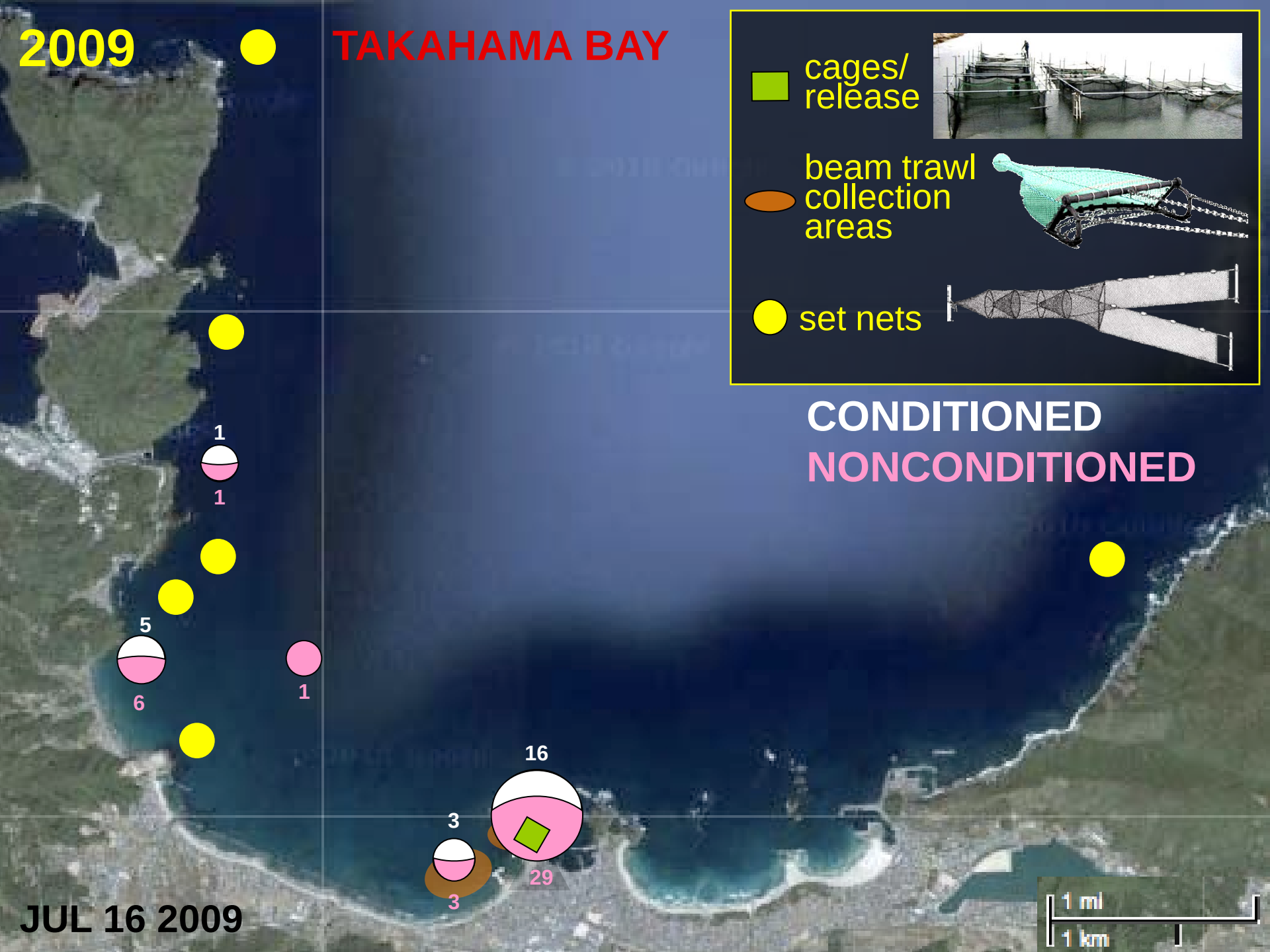

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
3
2
13
3
29
3
JUL 07 2009
1 mi
1 km

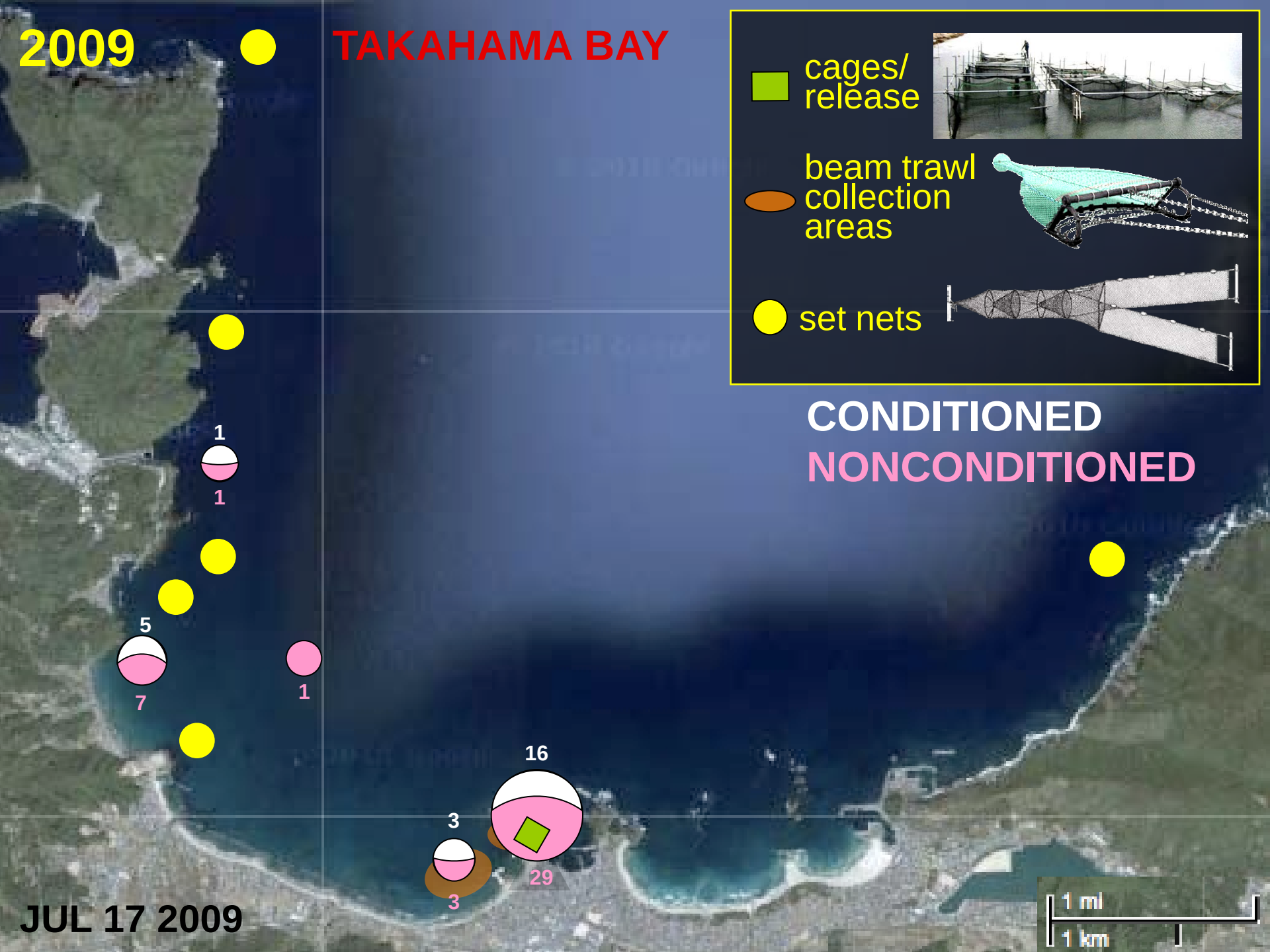

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
3
4
1
13
3
29
3
JUL 12 2009
1 mi
1 km

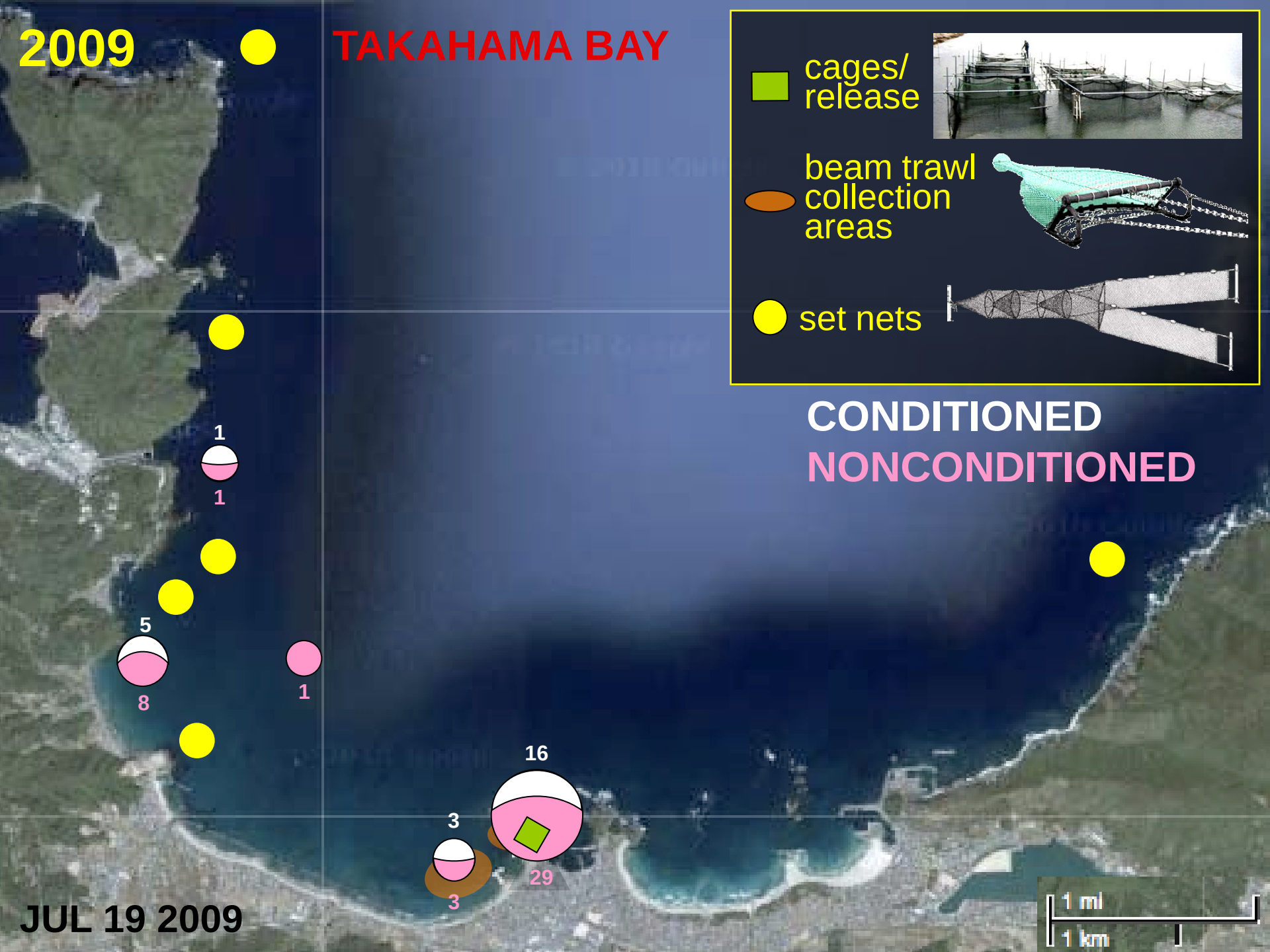

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
1
3
4
1
16
3
29
3
JUL 13 2009
1 mi
1 km

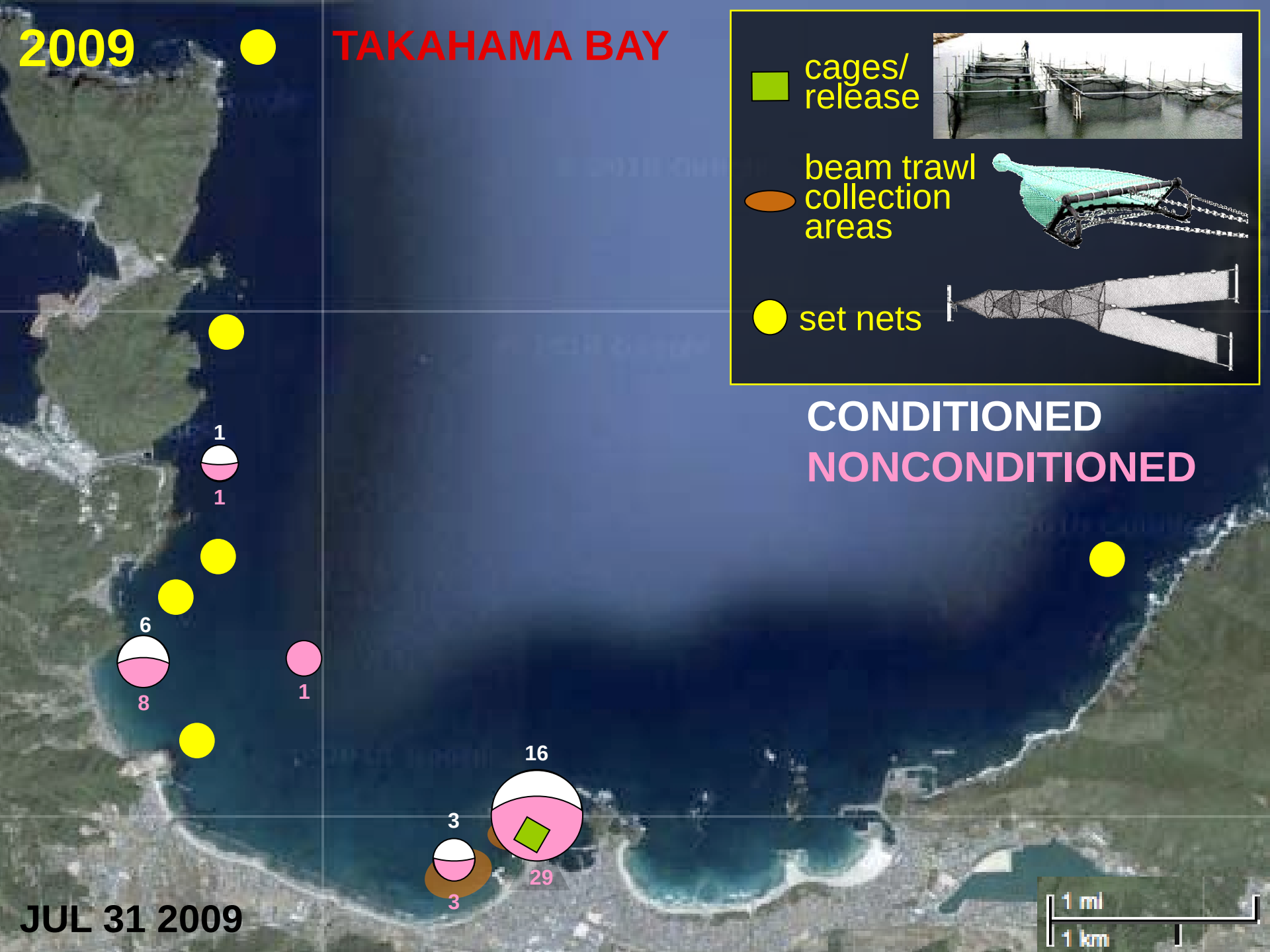

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
1
3
6
1
16
3
29
3
JUL 14 2009
1 mi
1 km

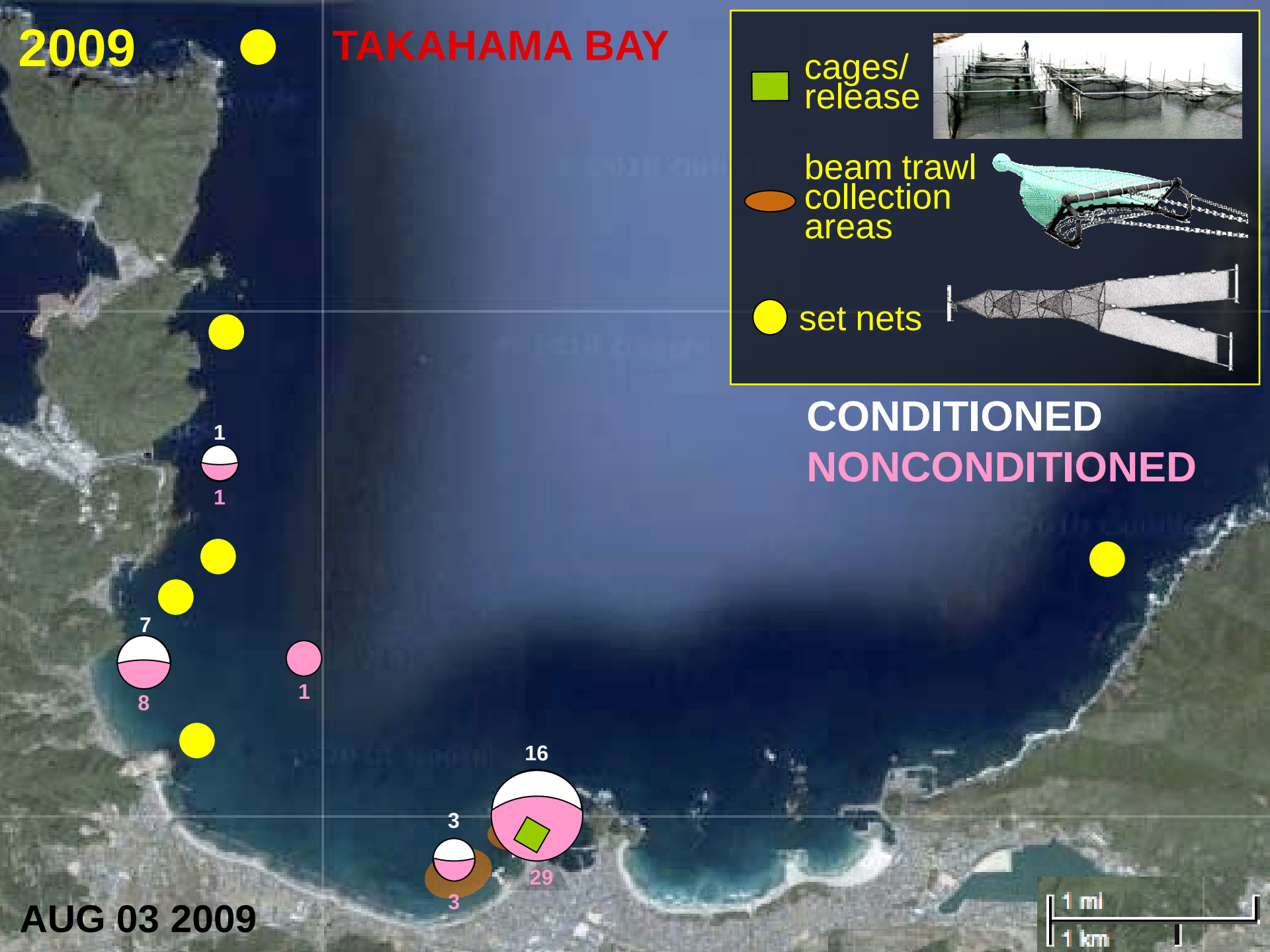

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
1
1
4
6
1
16
3
29
3
JUL 15 2009
1 mi
1 km

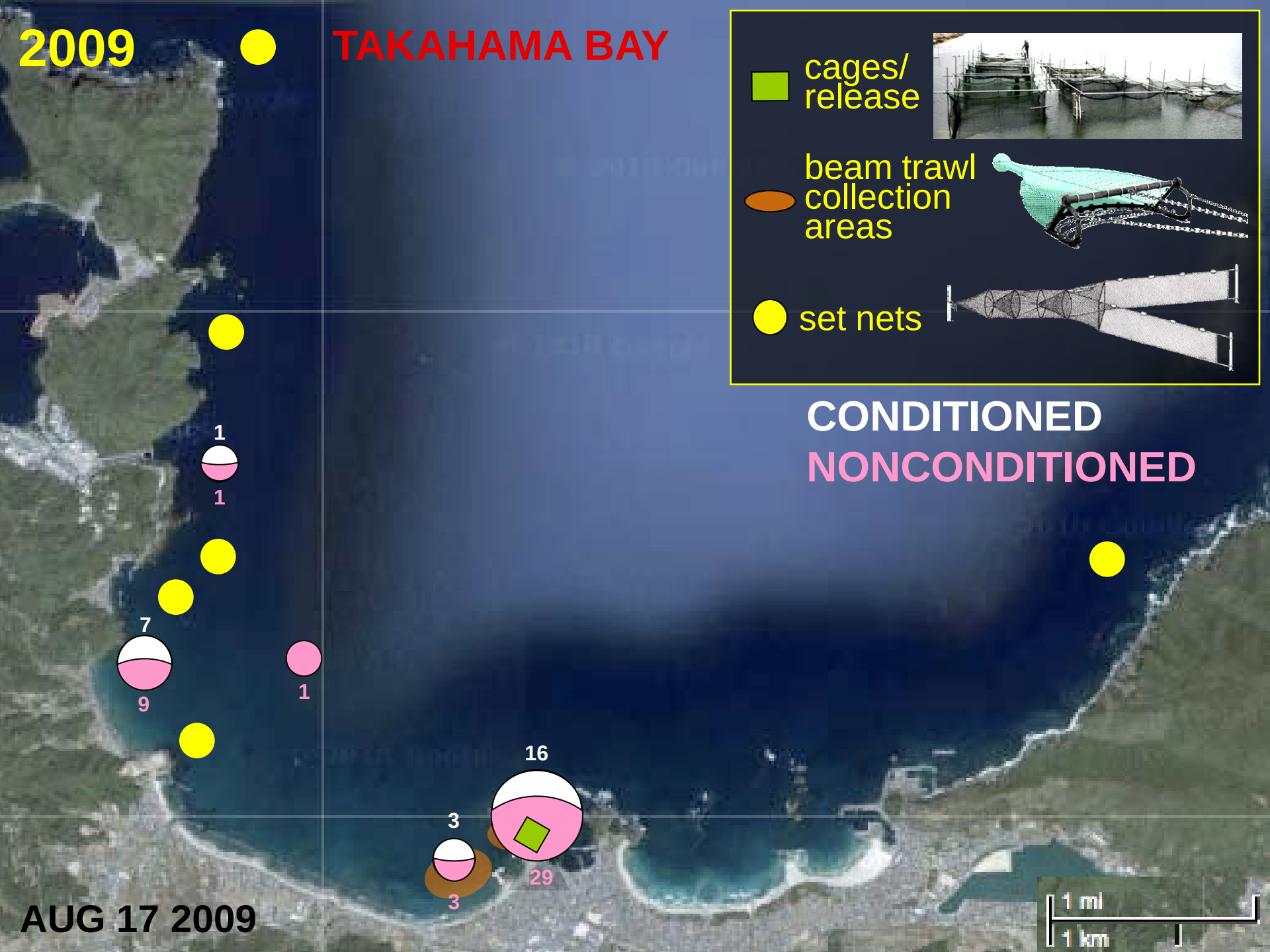

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
1
1
5
6
1
16
29
3
3
JUL 16 2009
1 mi
1 km

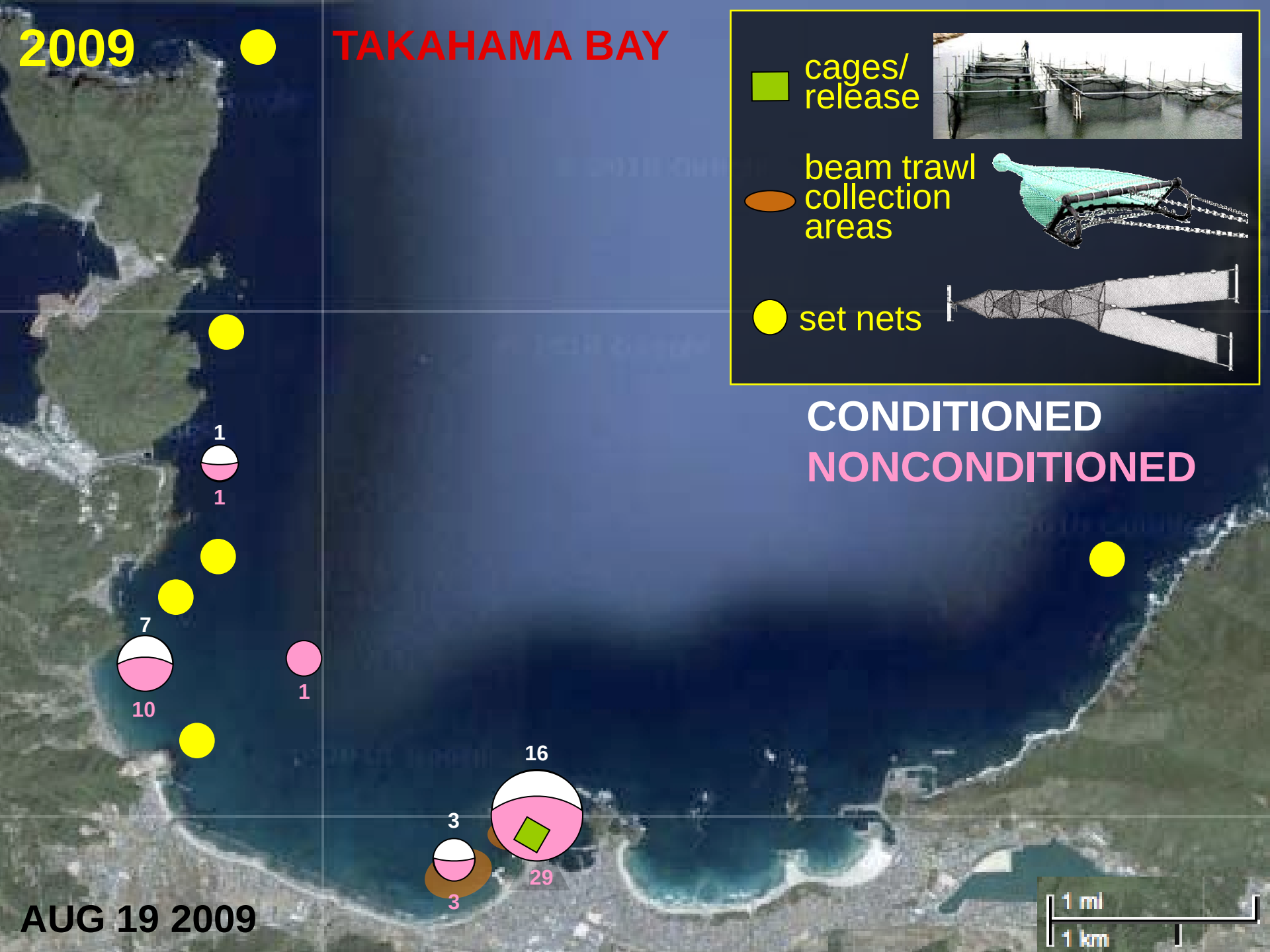

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
1
1
5
7
1
16
29
3
3
JUL 17 2009
1 mi
1 km

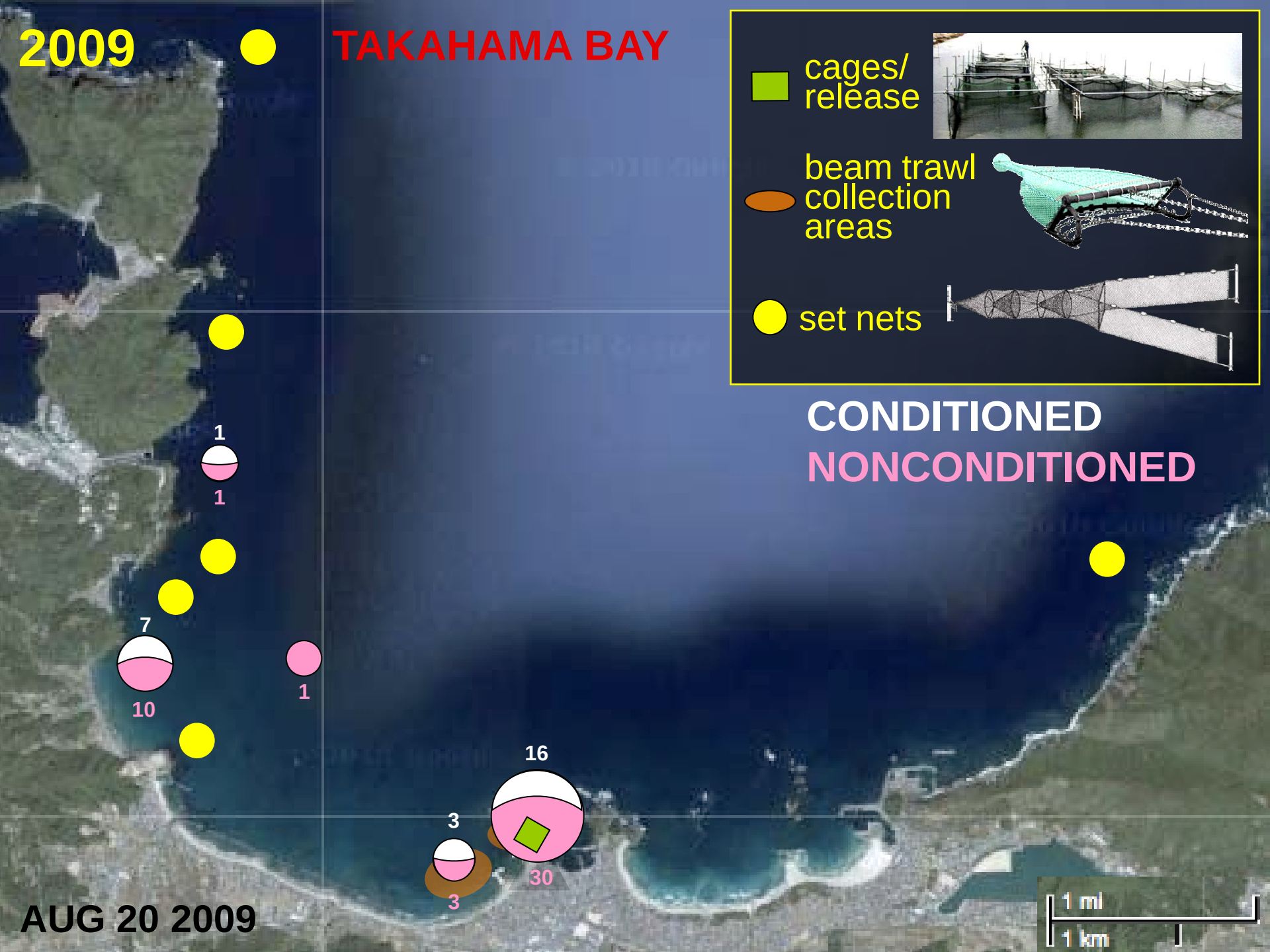

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
1
1
5
8
1
16
29
3
3
JUL 19 2009
1 mi
1 km

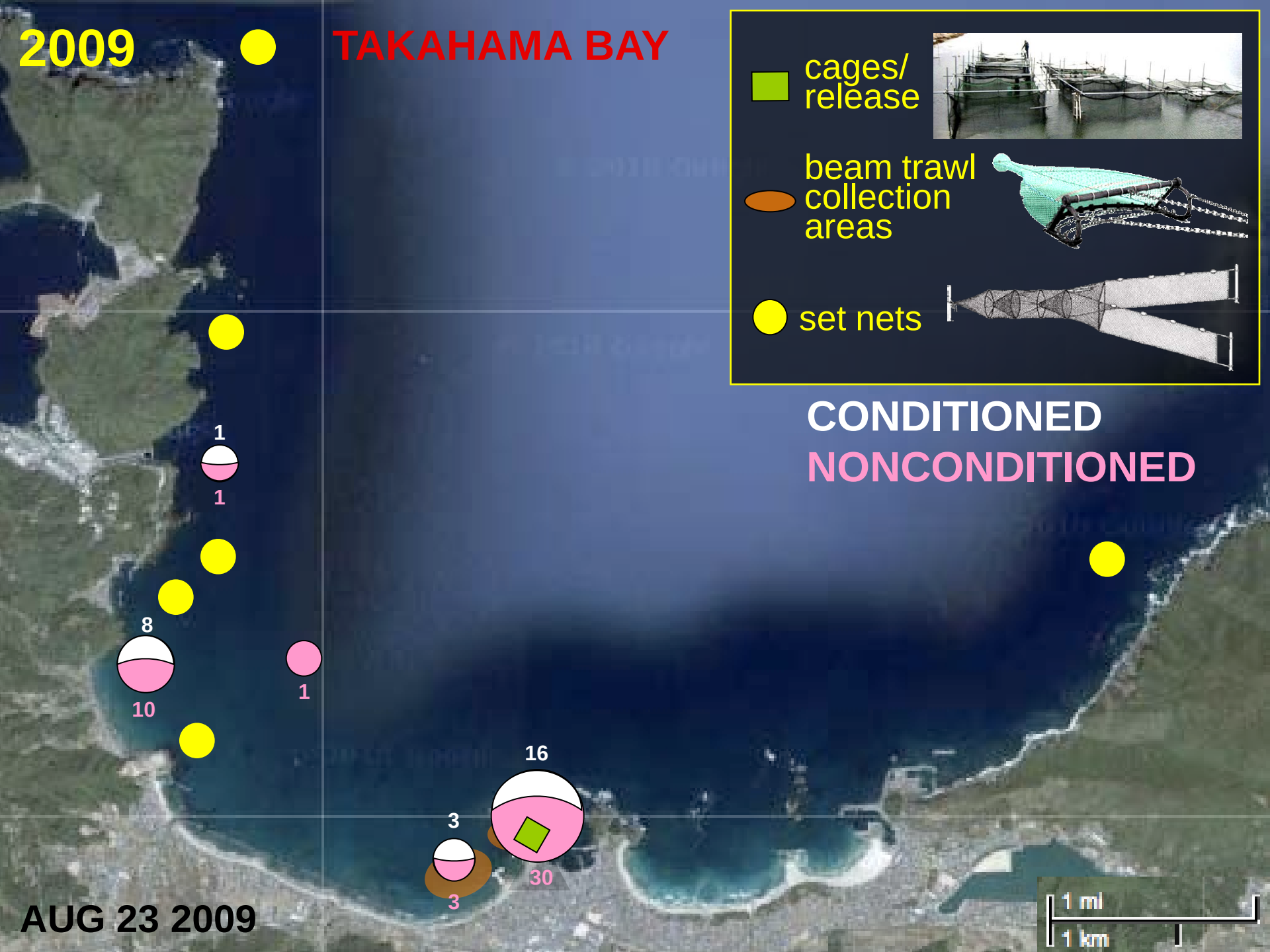

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
1
1
6
8
1
16
29
3
3
JUL 31 2009
1 mi
1 km

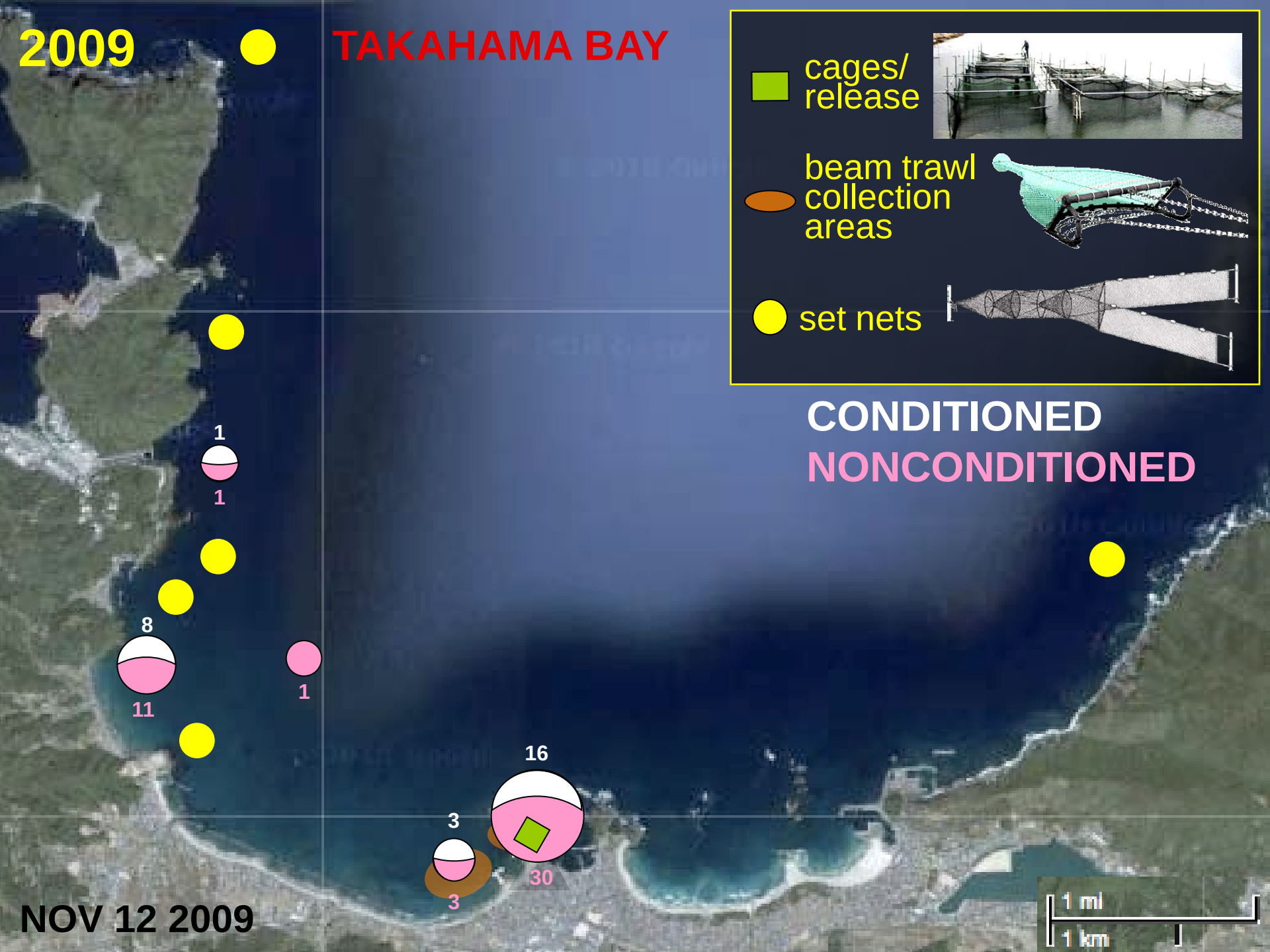

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
1
1
7
8
1
16
29
3
3
AUG 03 2009
1 mi
1 km


2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
1
1
7
9
1
16
29
3
3
AUG 17 2009
1 mi
1 km

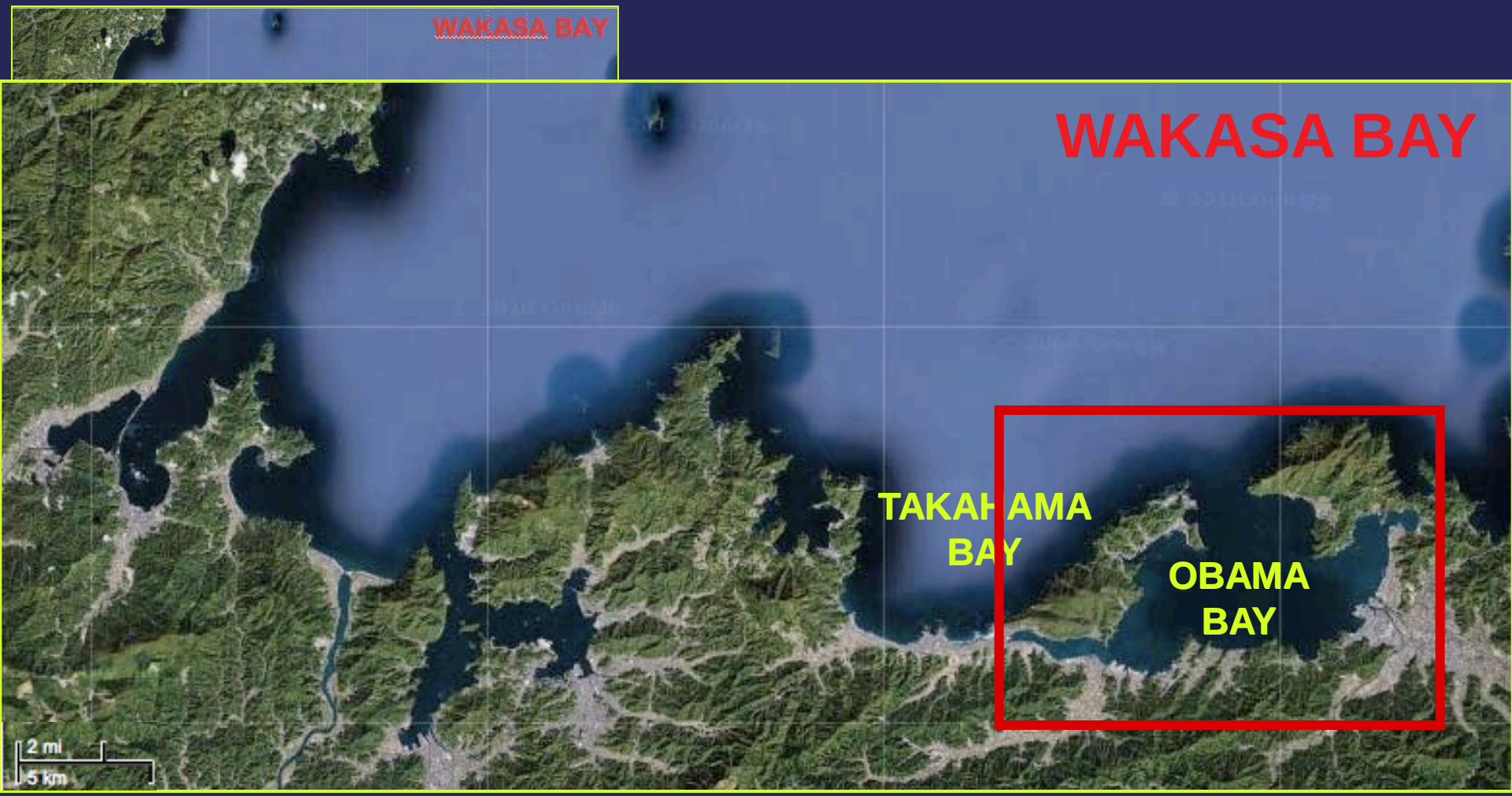

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
1
1
7
10
1
16
29
3
3
AUG 19 2009
1 mi
1 km


2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
1
1
7
10
1
16
30
3
3
AUG 20 2009
1 mi
1 km

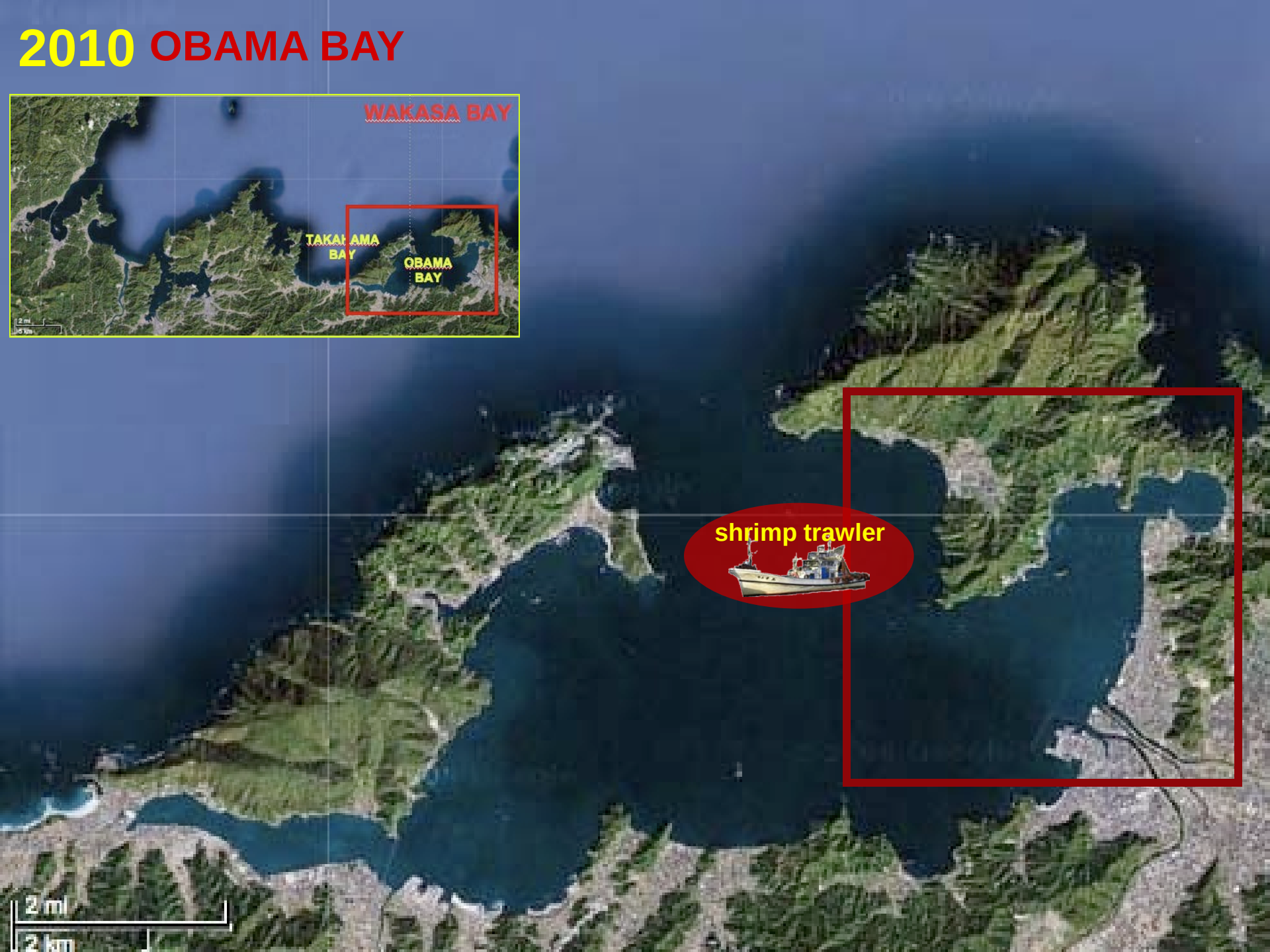

2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
1
1
8
10
1
16
30
3
3
AUG 23 2009
1 mi
1 km


2009
TAKAHAMA BAY
cages/ release
beam trawl collection areas
set nets
CONDITIONED
NONCONDITIONED
1
1
8
11
1
16
30
3
3
NOV 12 2009
1 mi
1 km

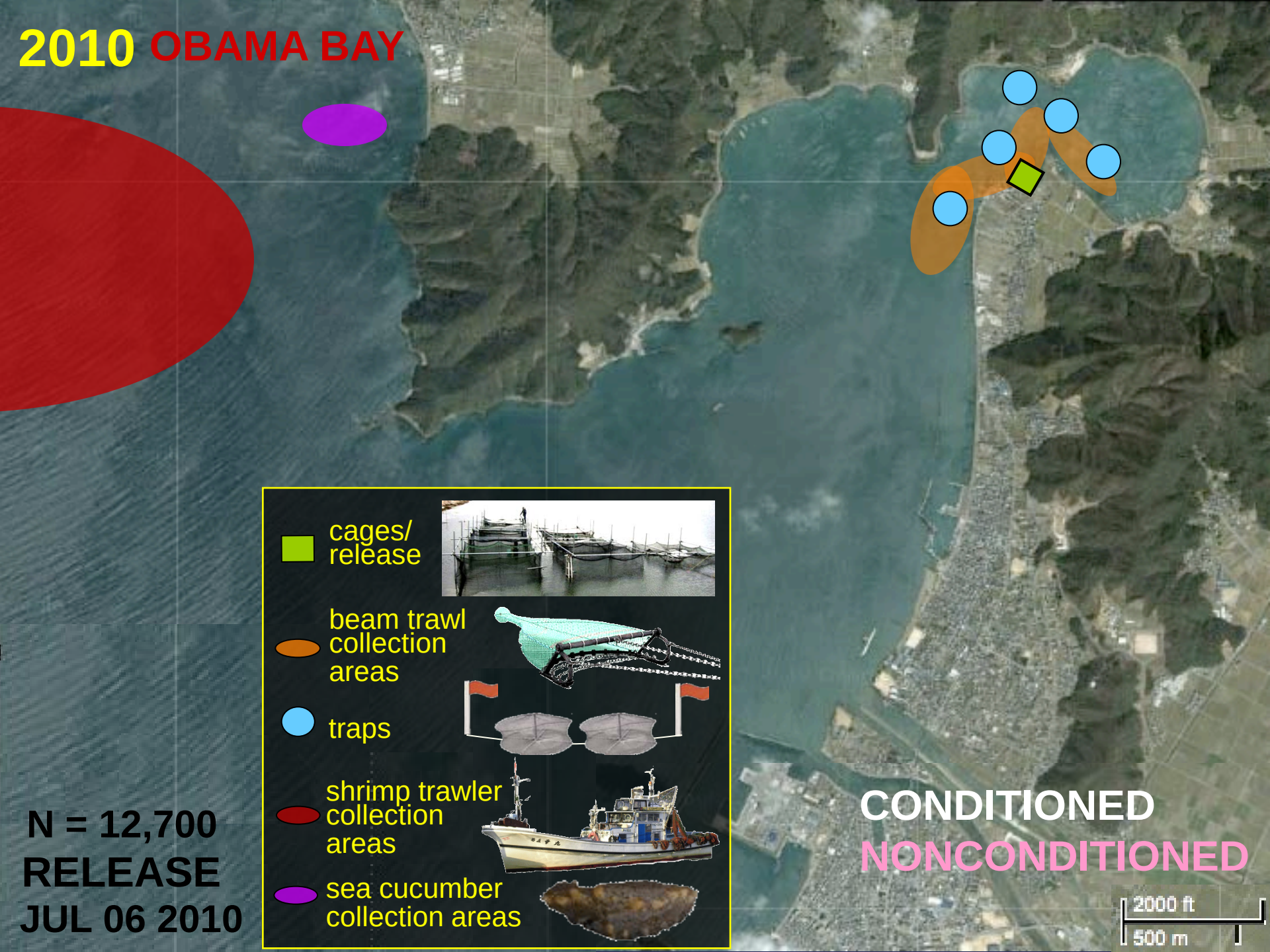
2010 OBAMA BAY



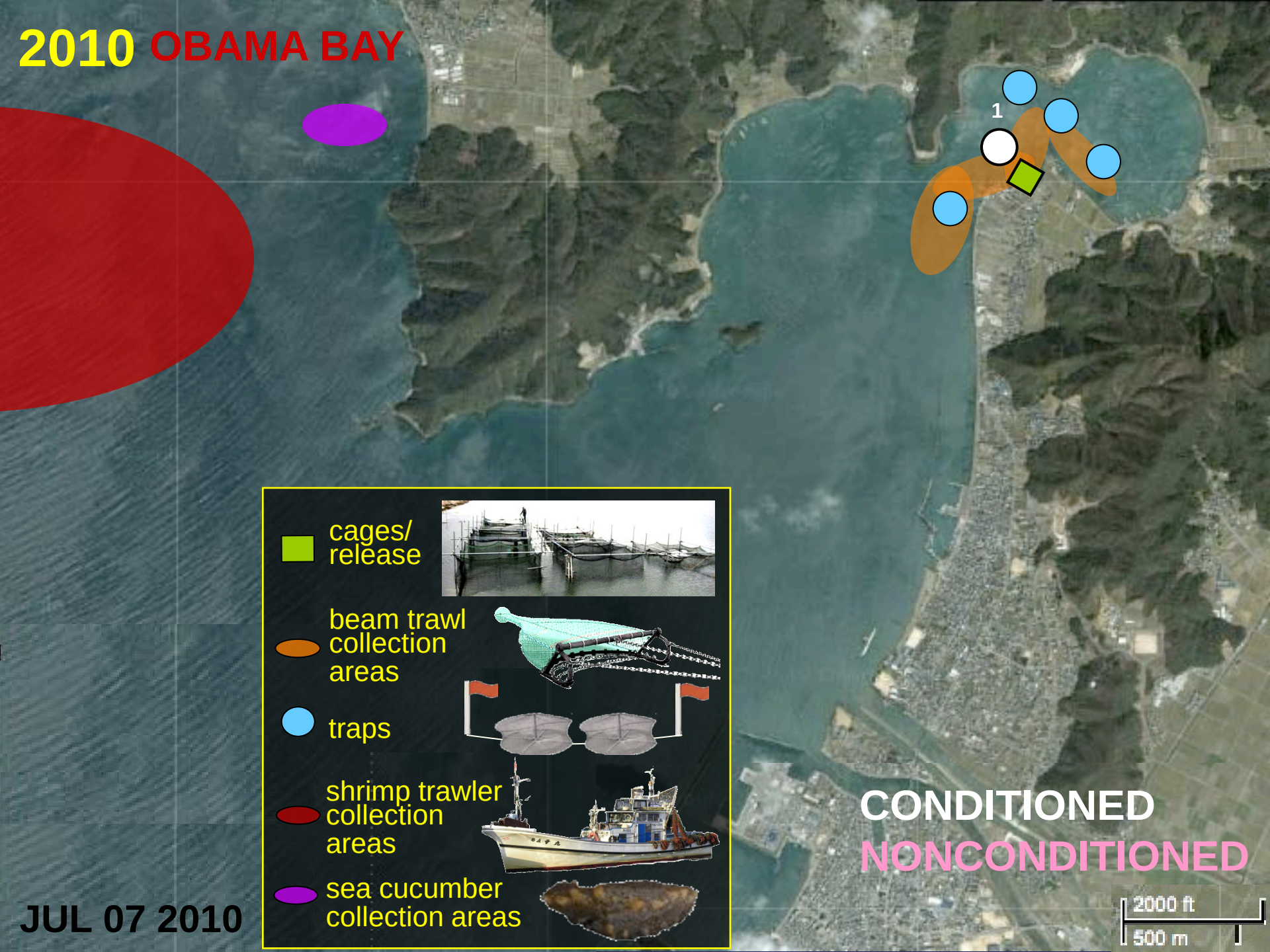
2010 OBAMA BAY

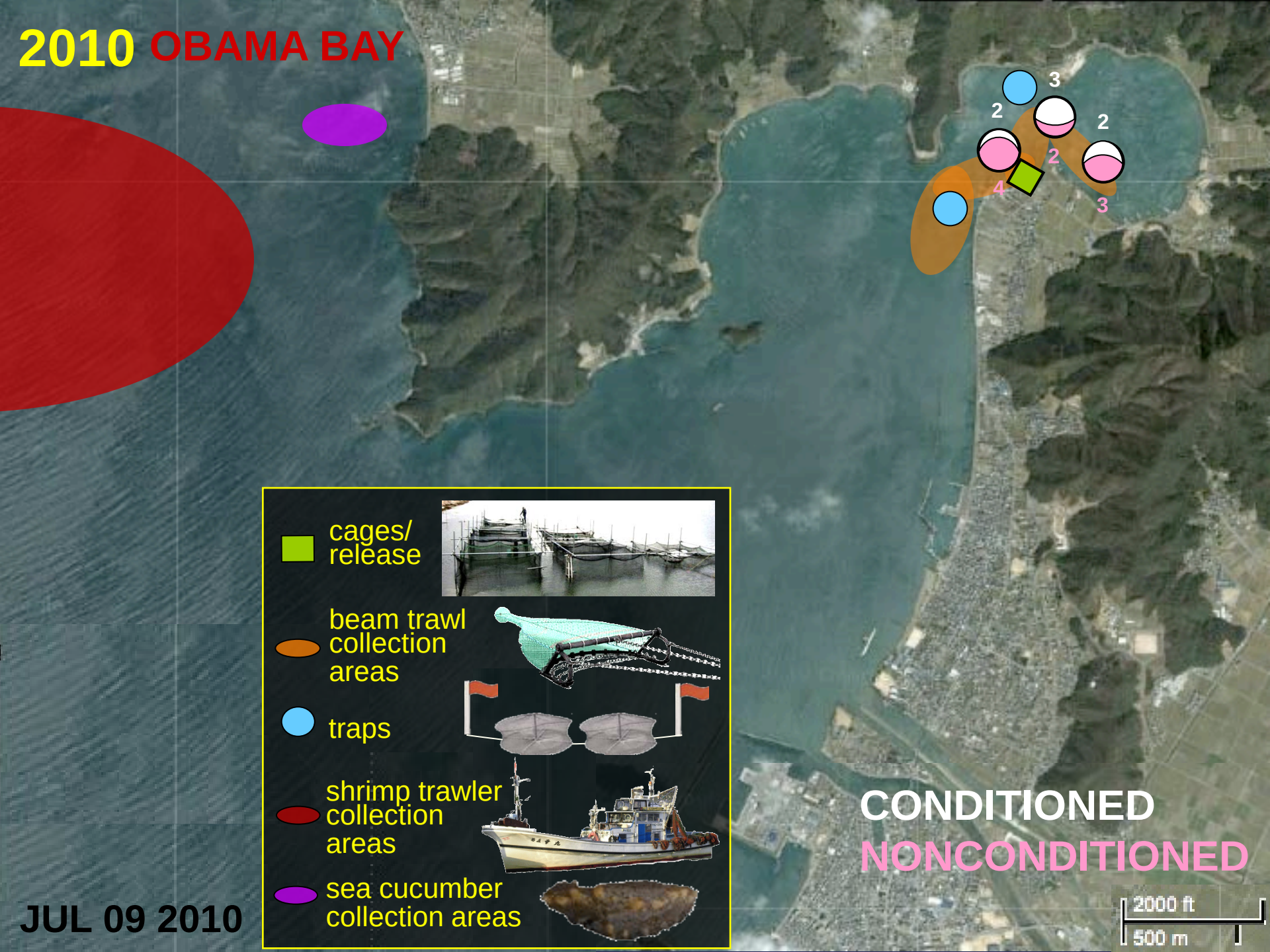


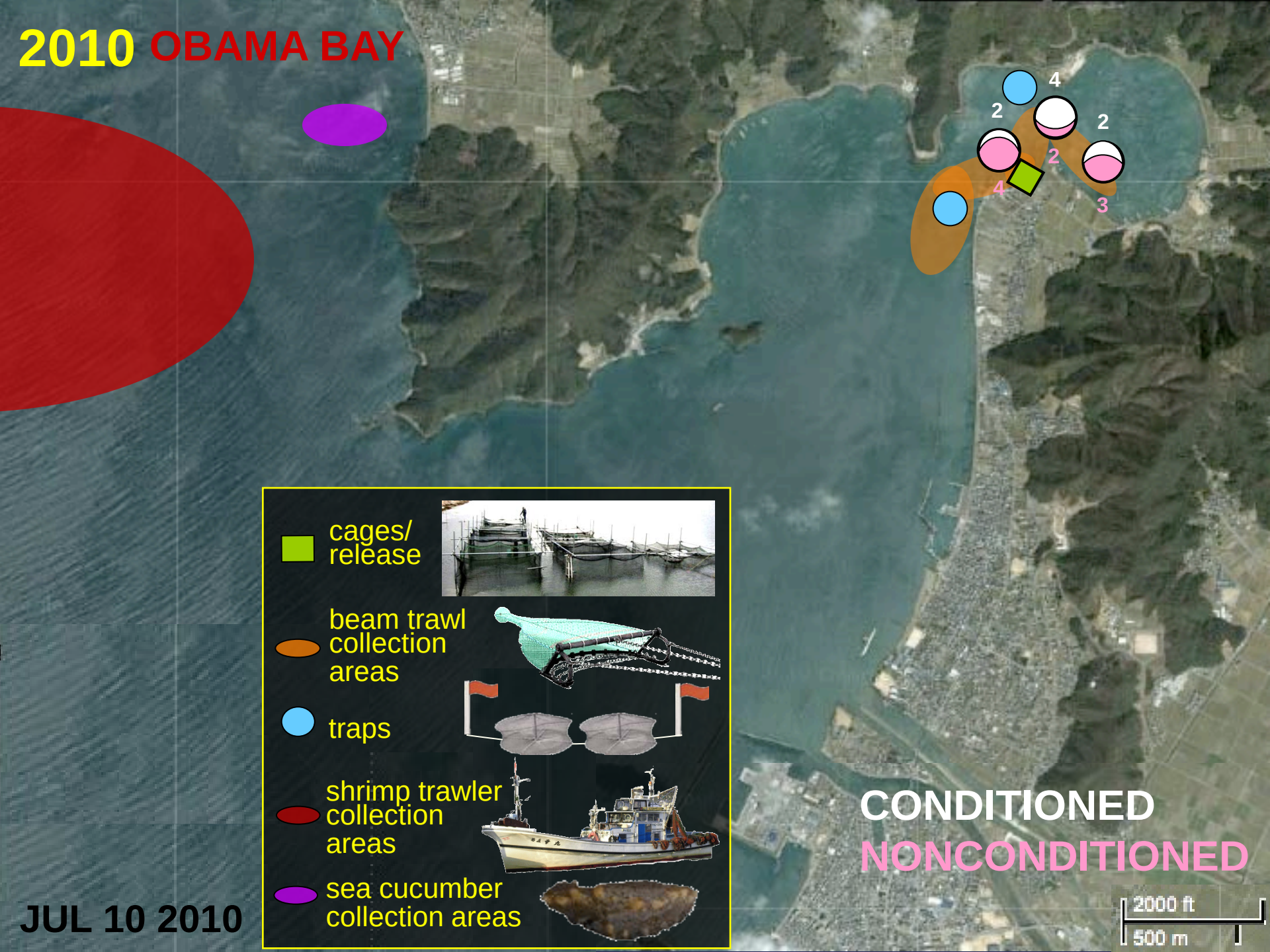
2010 OBAMA BAY

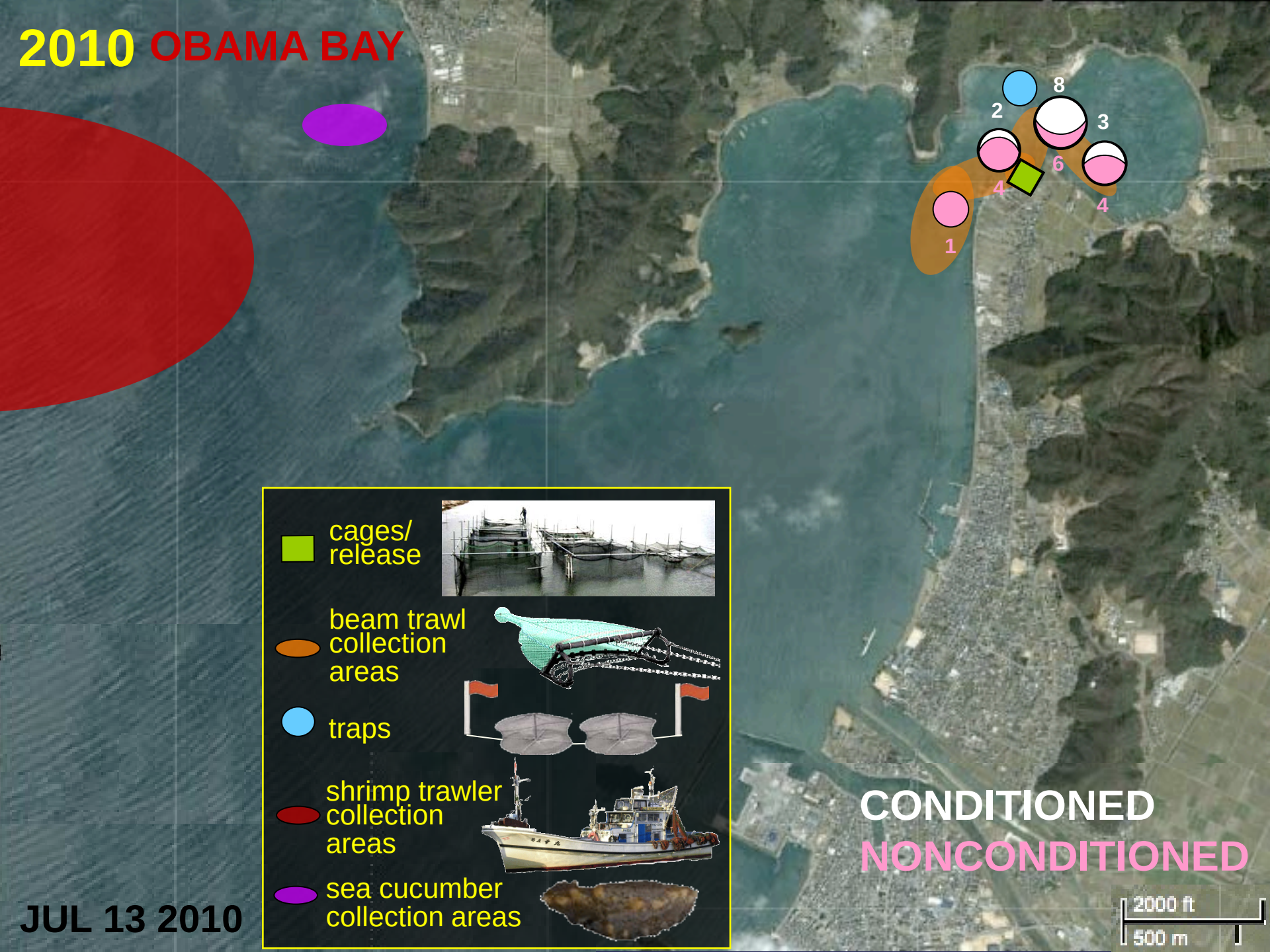


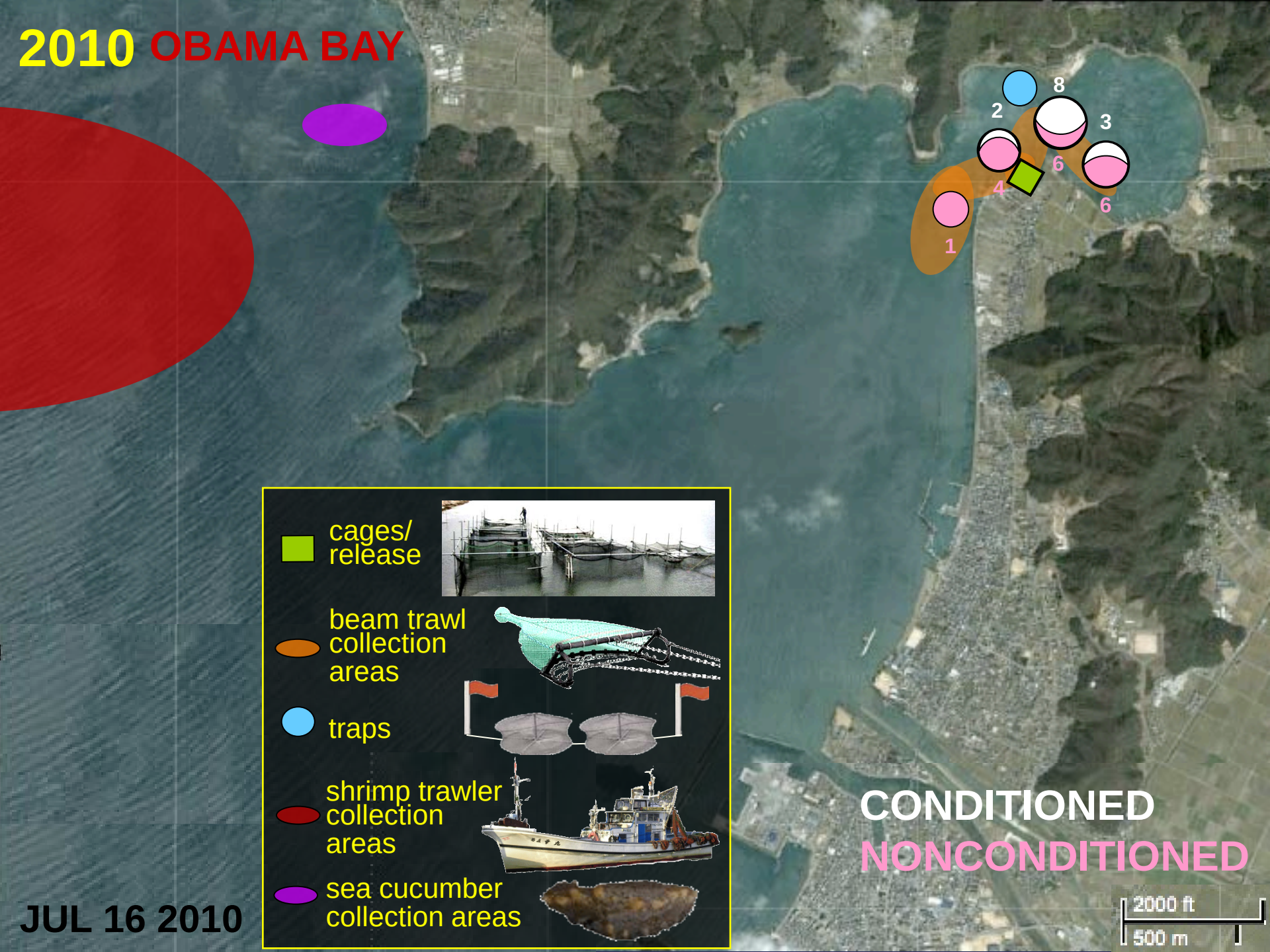
N = 12,700
RELEASE
JUL 06 2010

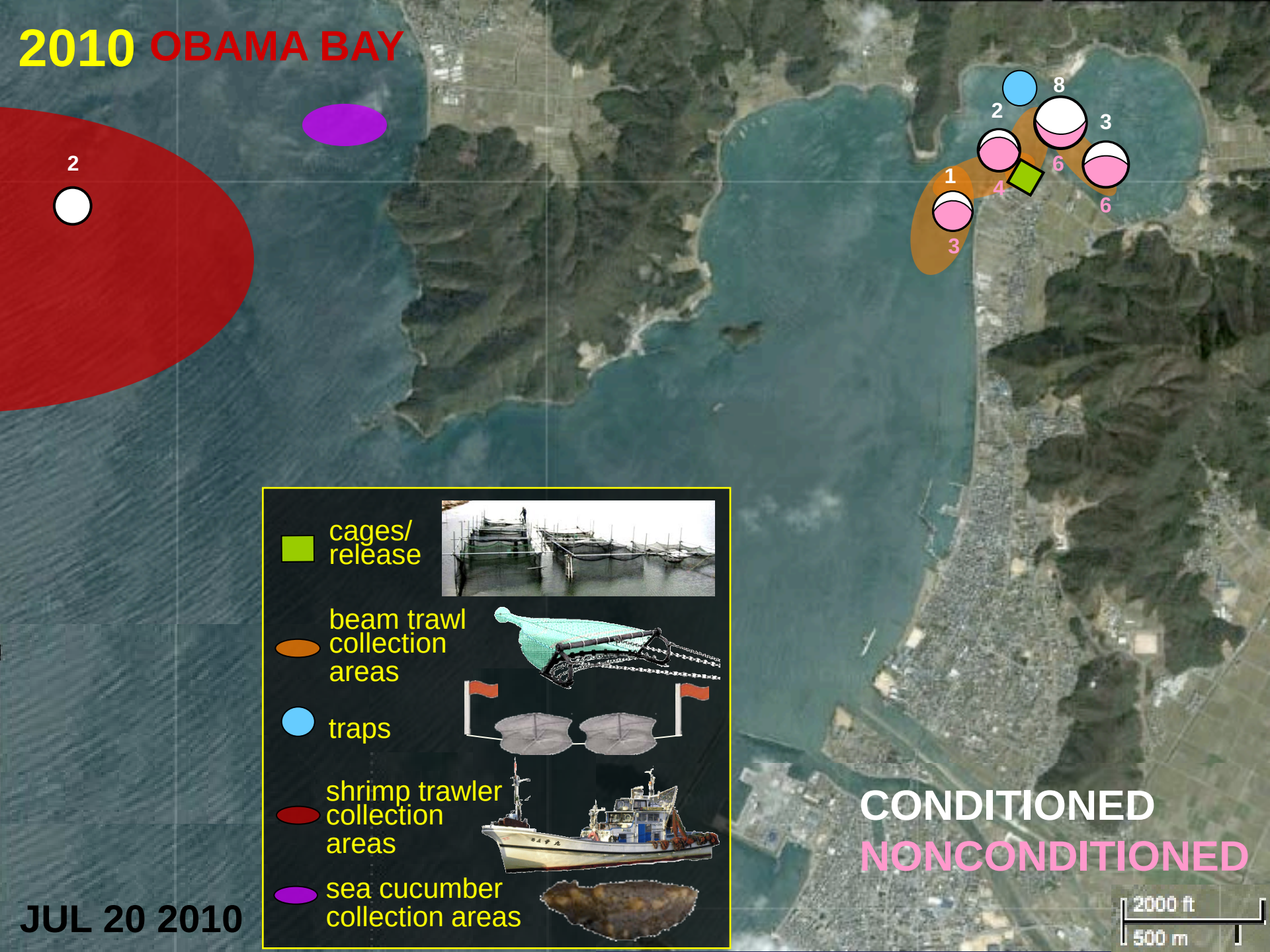

2010 OBAMA BAY
1
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUL 07 2010

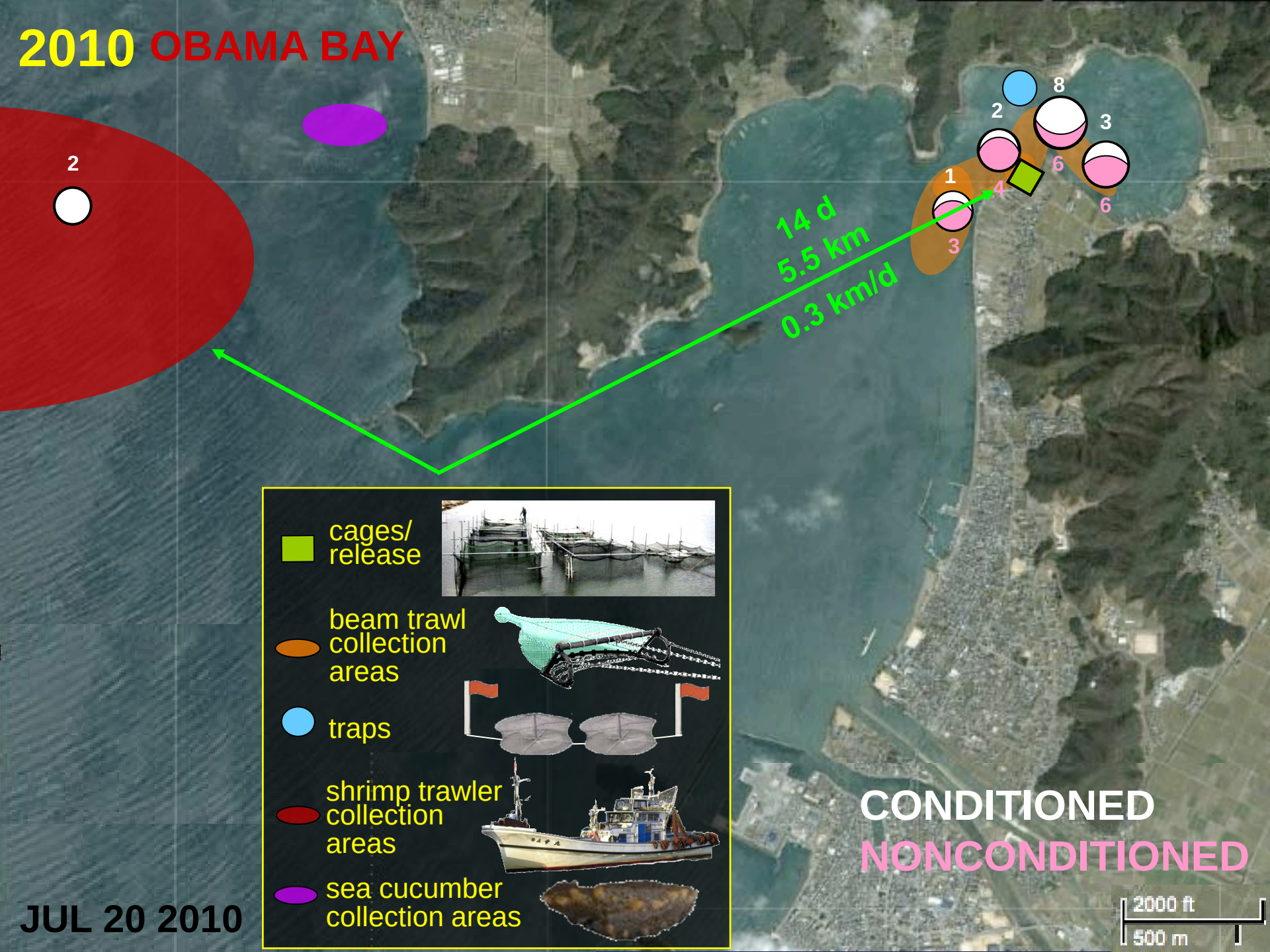

2010 OBAMA BAY
3
2
2
2
4
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUL 09 2010

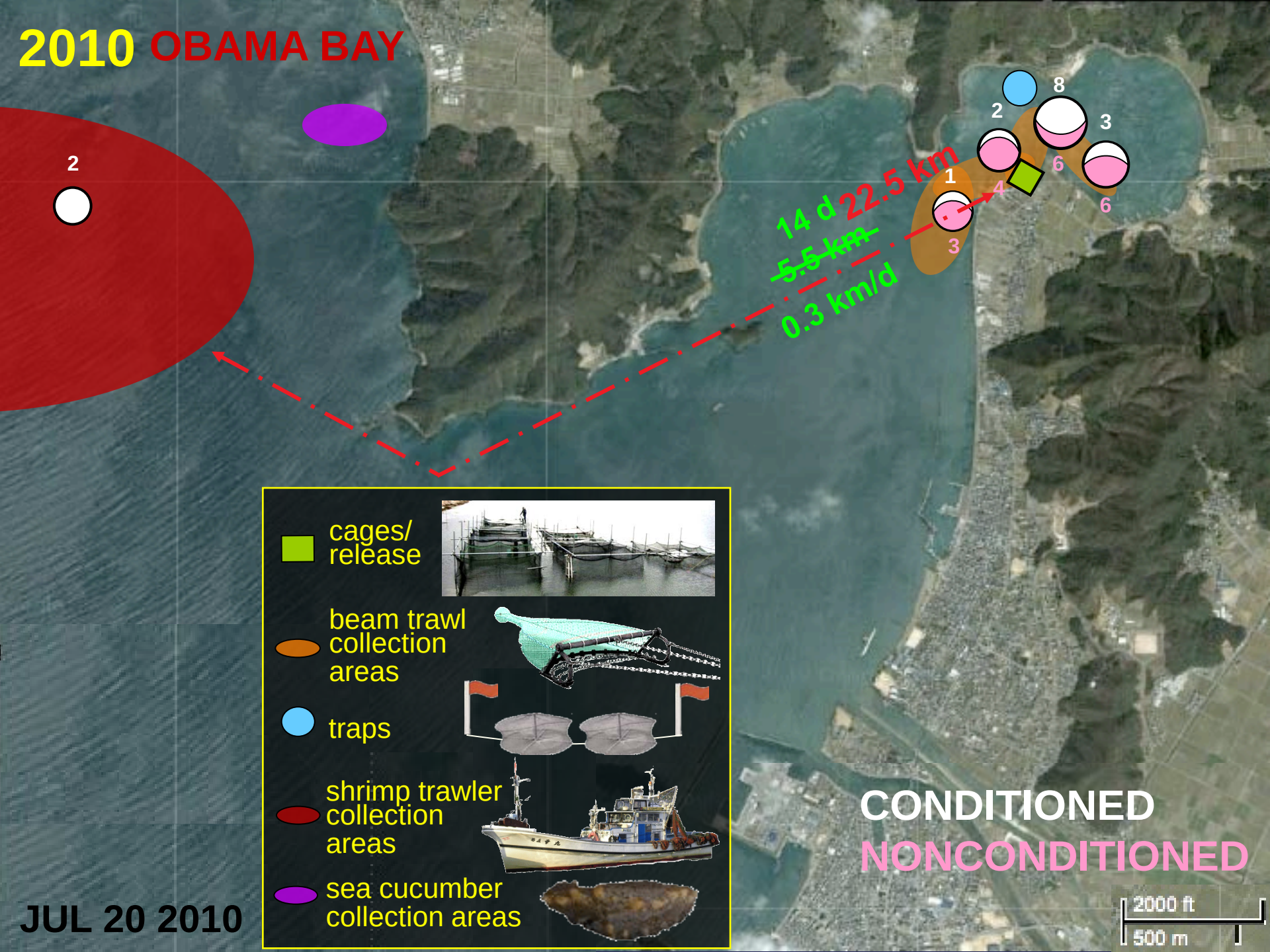

2010 OBAMA BAY
4
2
2
2
4
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUL 10 2010

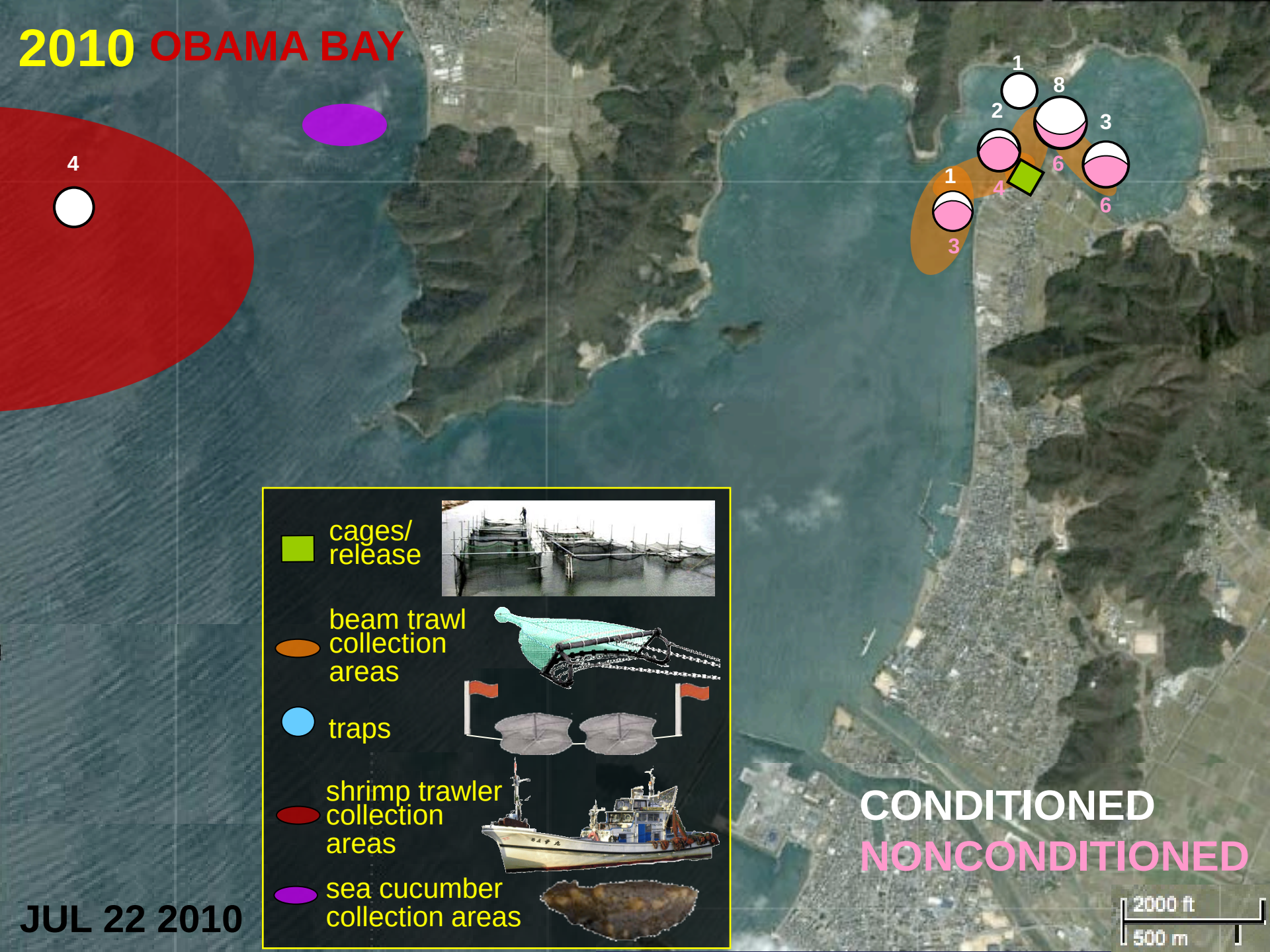

2010 OBAMA BAY
8
2
3
6
4
4
1
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUL 13 2010

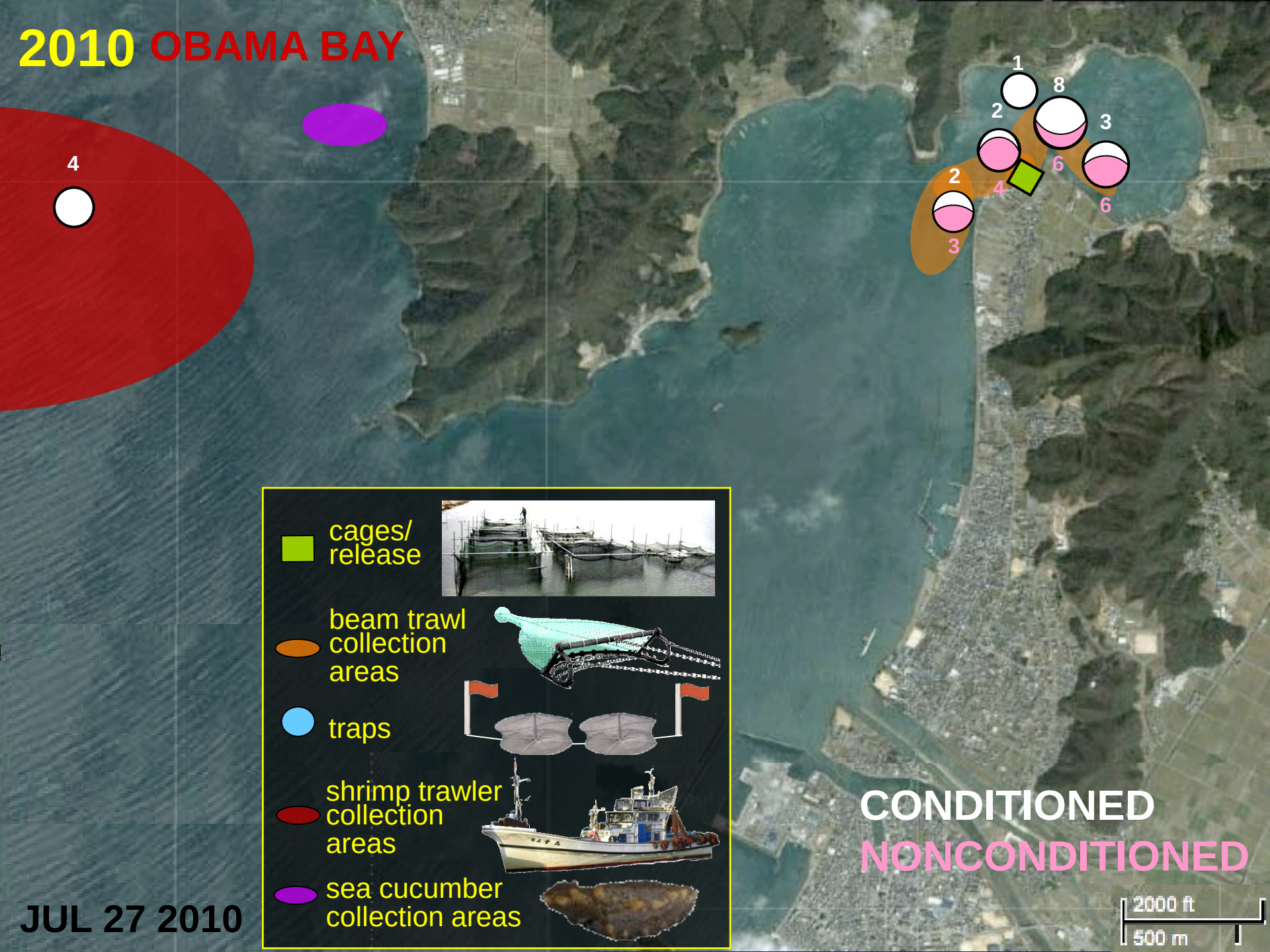

2010 OBAMA BAY
8
2
3
6
4
6
1
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUL 16 2010

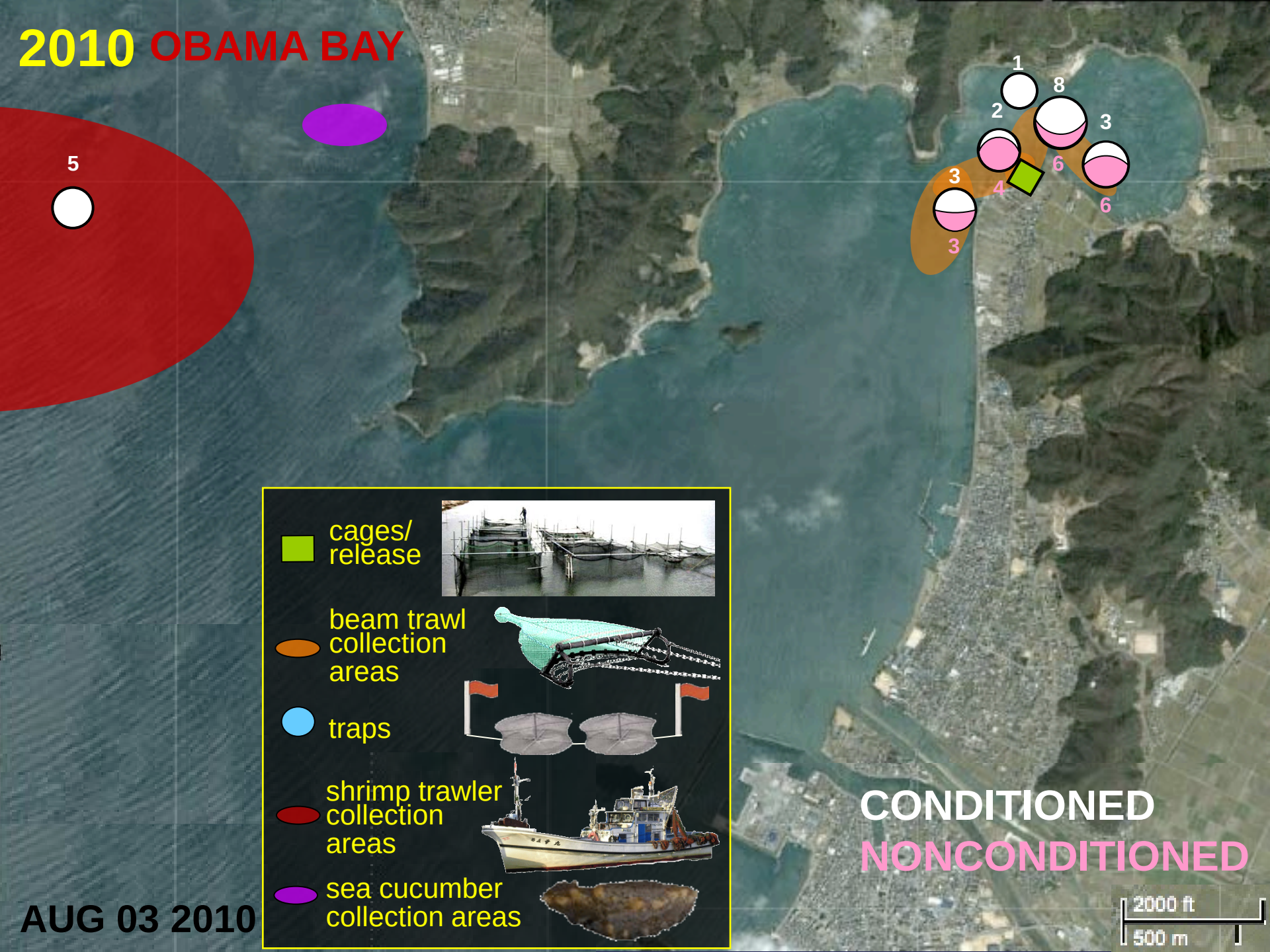

2010 OBAMA BAY
2
8
2
3
6
1
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUL 20 2010

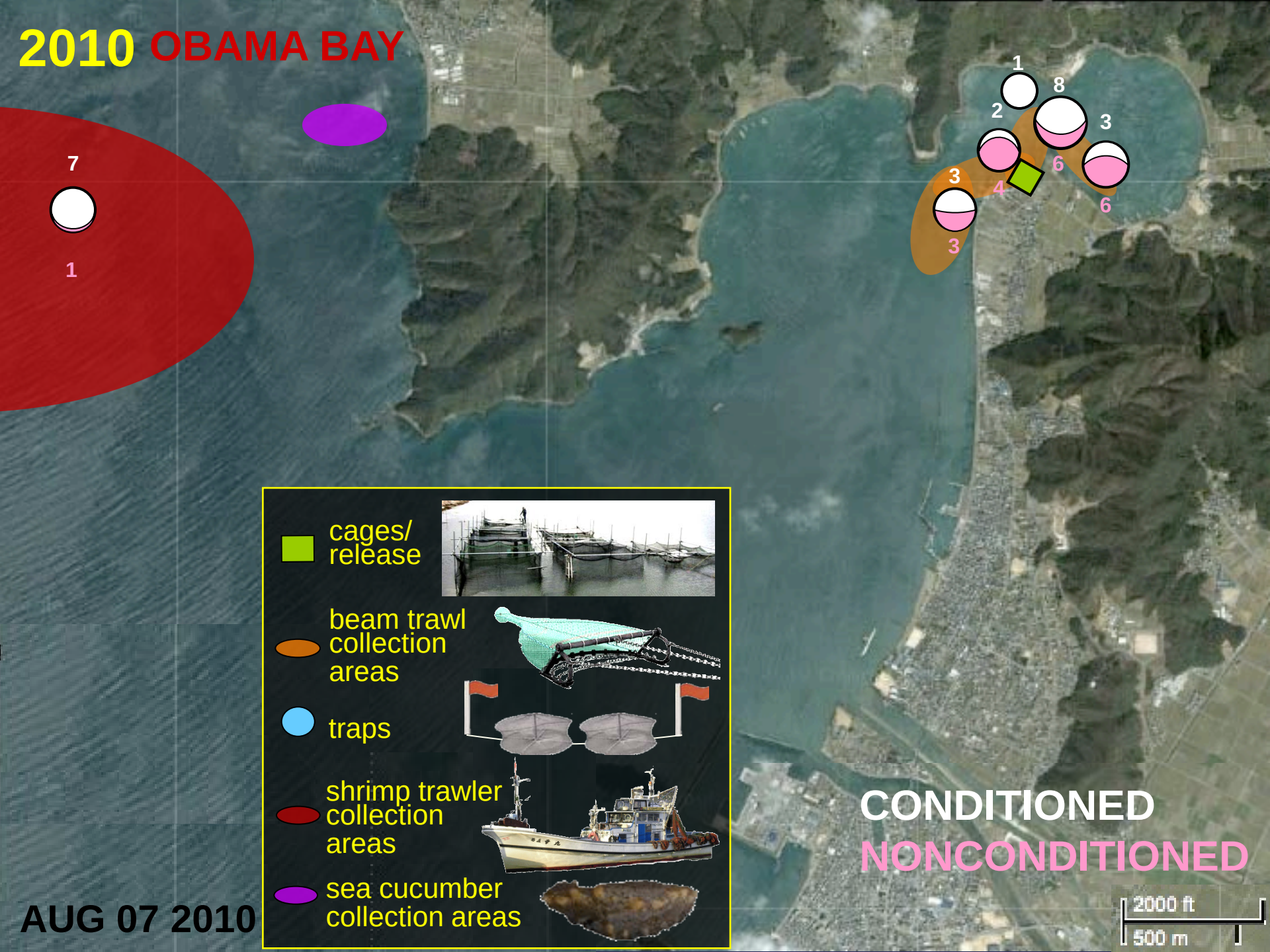

2010 OBAMA BAY
2
8
2
3
6
1
4
6
3
14 d
5.5 km
0.3 km/d
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUL 20 2010


2010 OBAMA BAY
2
8
2
3
6
1
4
6
3
14 d
22.5 km
5.5 km
0.3 km/d
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUL 20 2010

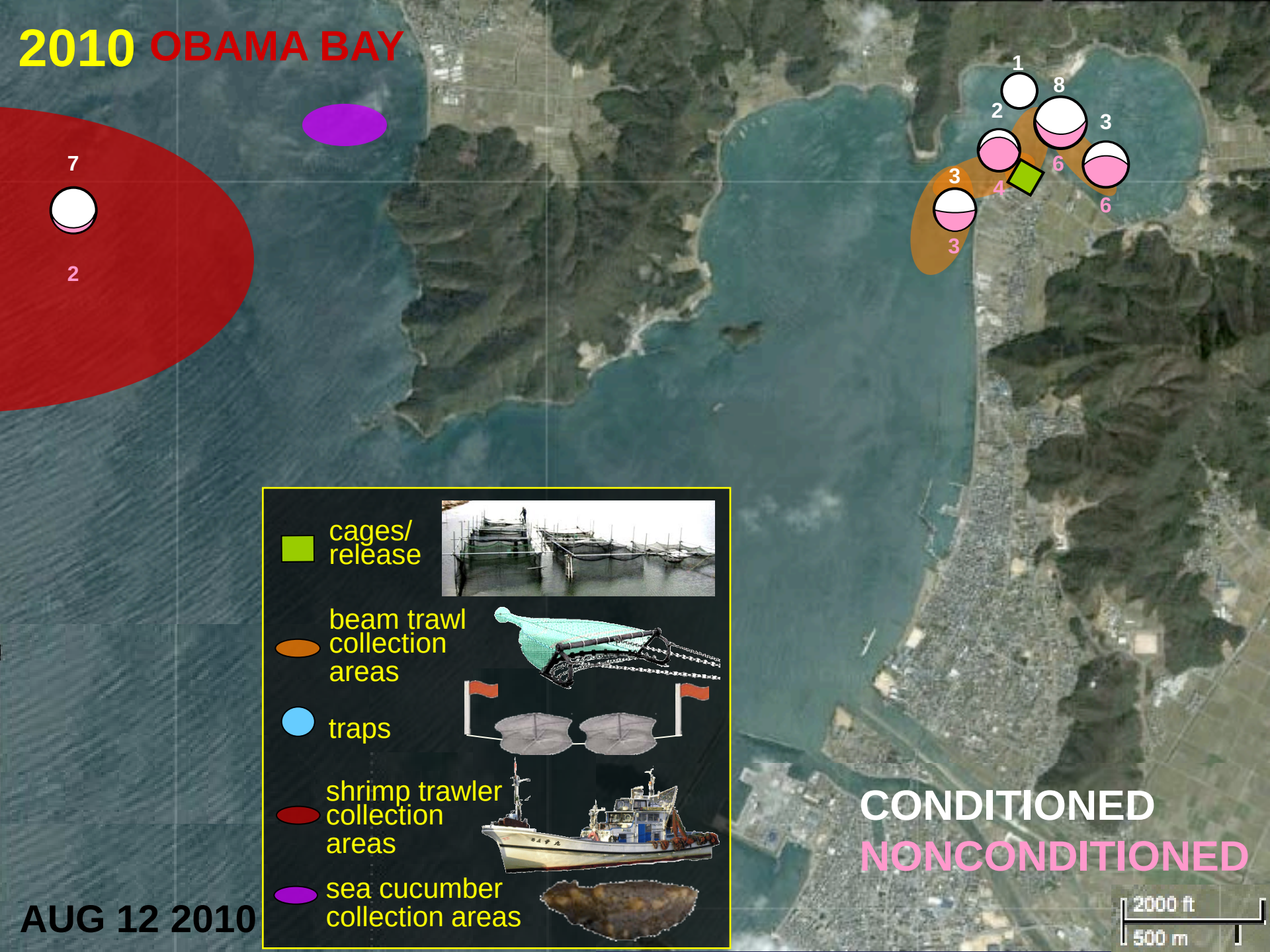

2010 OBAMA BAY
4
1
8
2
3
6
1
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUL 22 2010


2010 OBAMA BAY
4
1
8
2
3
6
2
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUL 27 2010


2010 OBAMA BAY
5
1
8
2
3
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
AUG 03 2010


2010 OBAMA BAY
7
1
1
8
2
3
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
AUG 07 2010

2010 OBAMA BAY



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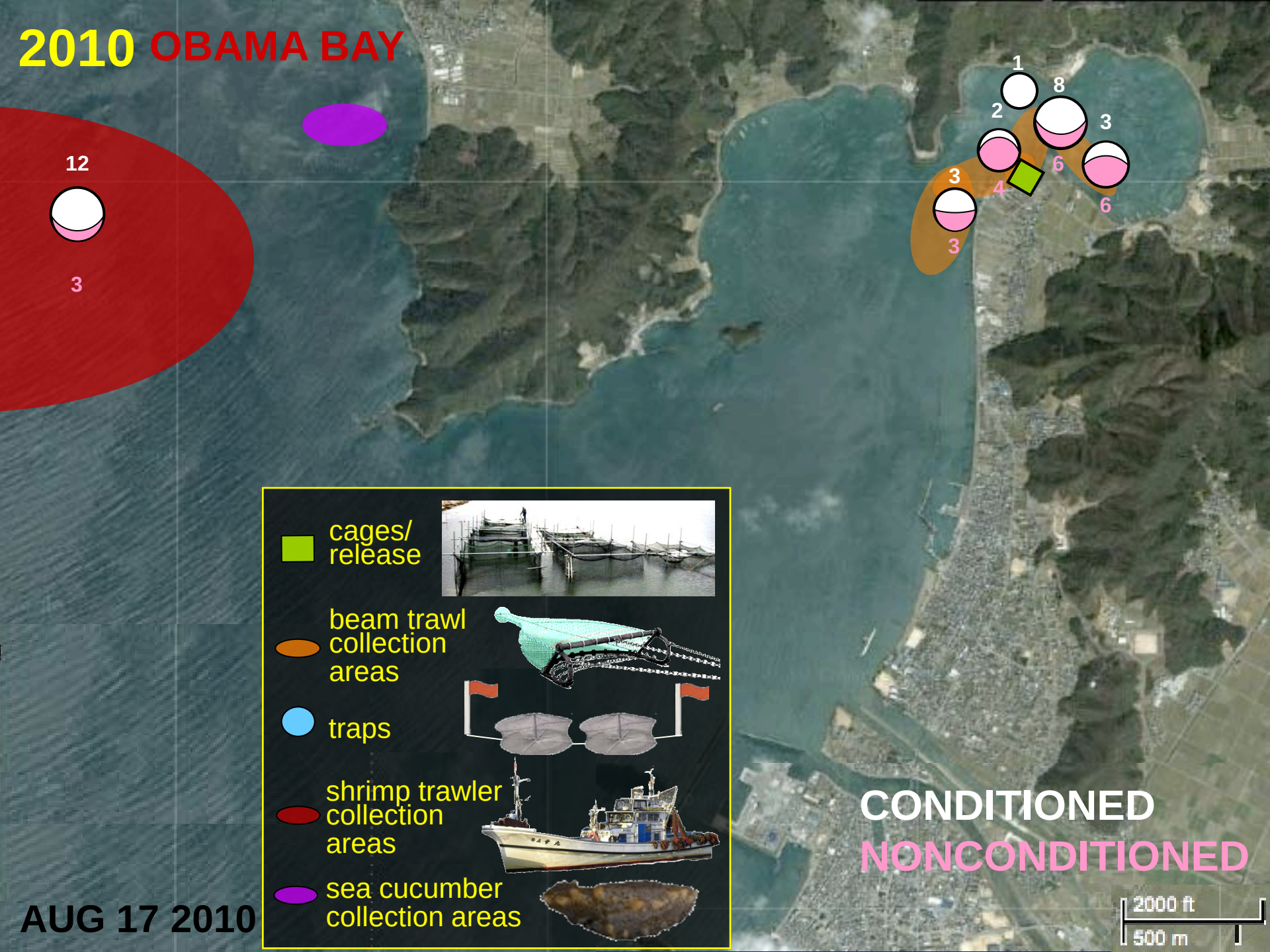
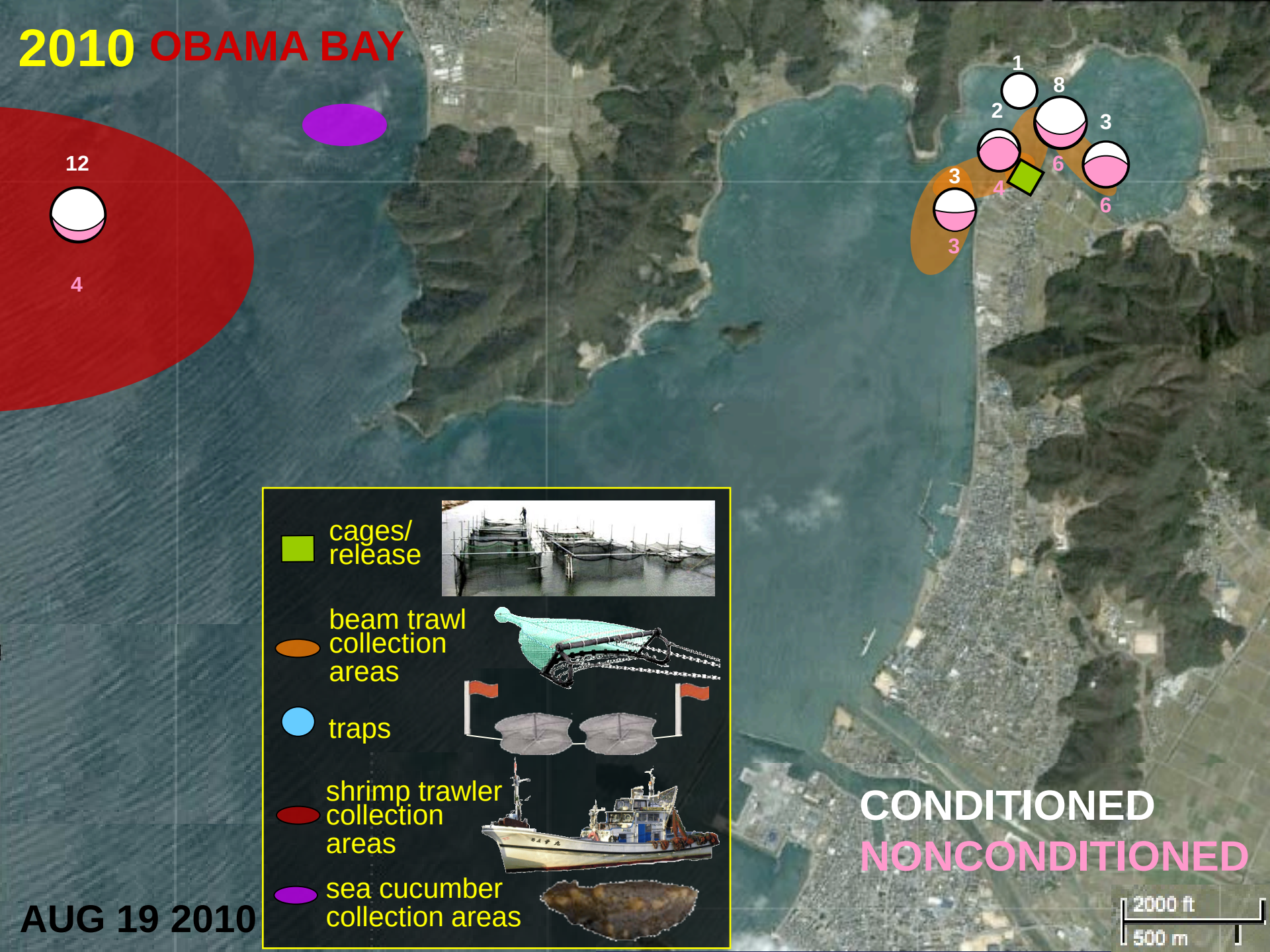

2010 OBAMA BAY
12
3
1
8
2
3
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
AUG 17 2010


2010 OBAMA BAY
12
4
1
8
2
3
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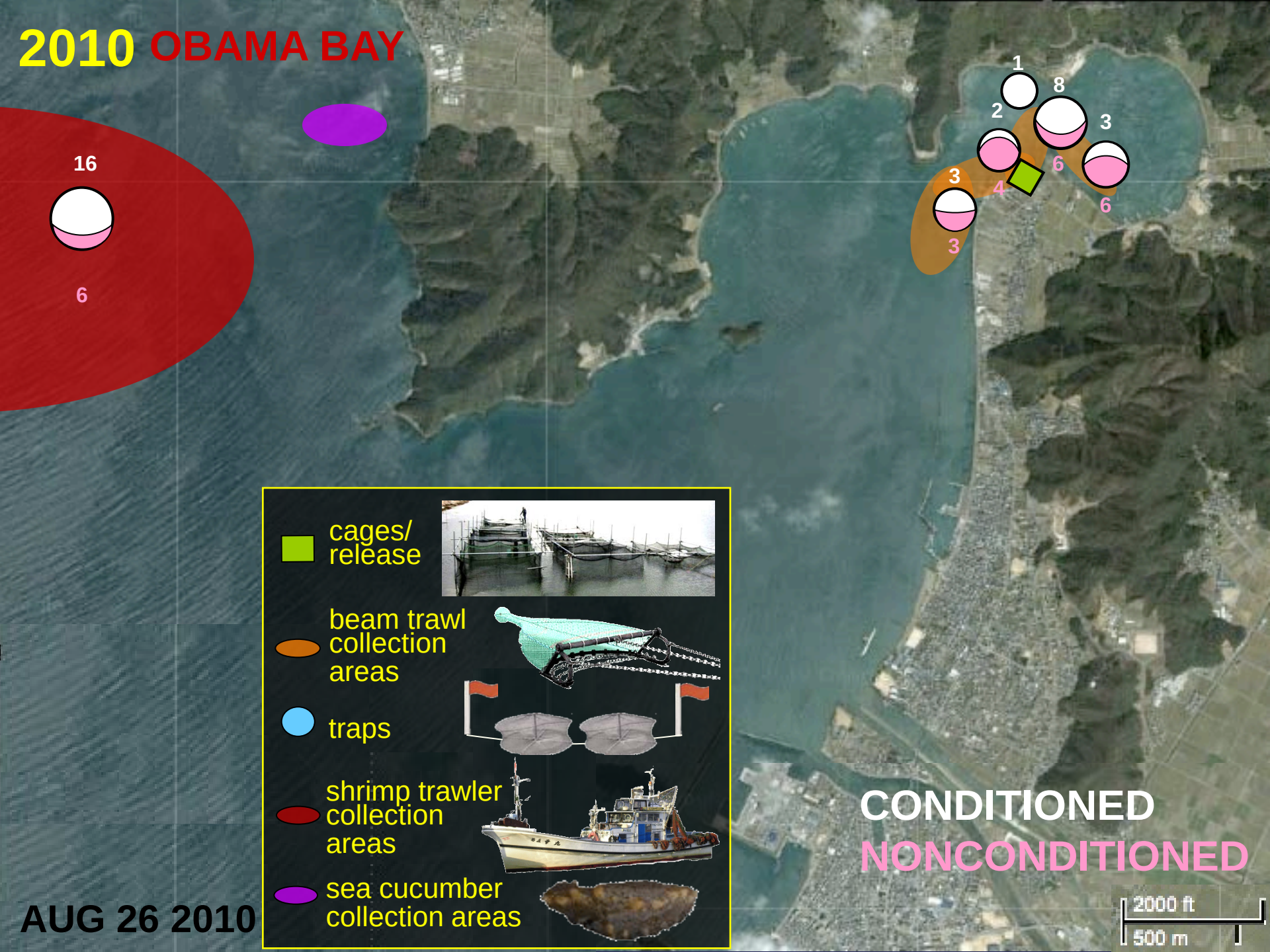
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
AUG 19 2010


2010 OBAMA BAY
16
6
1
8
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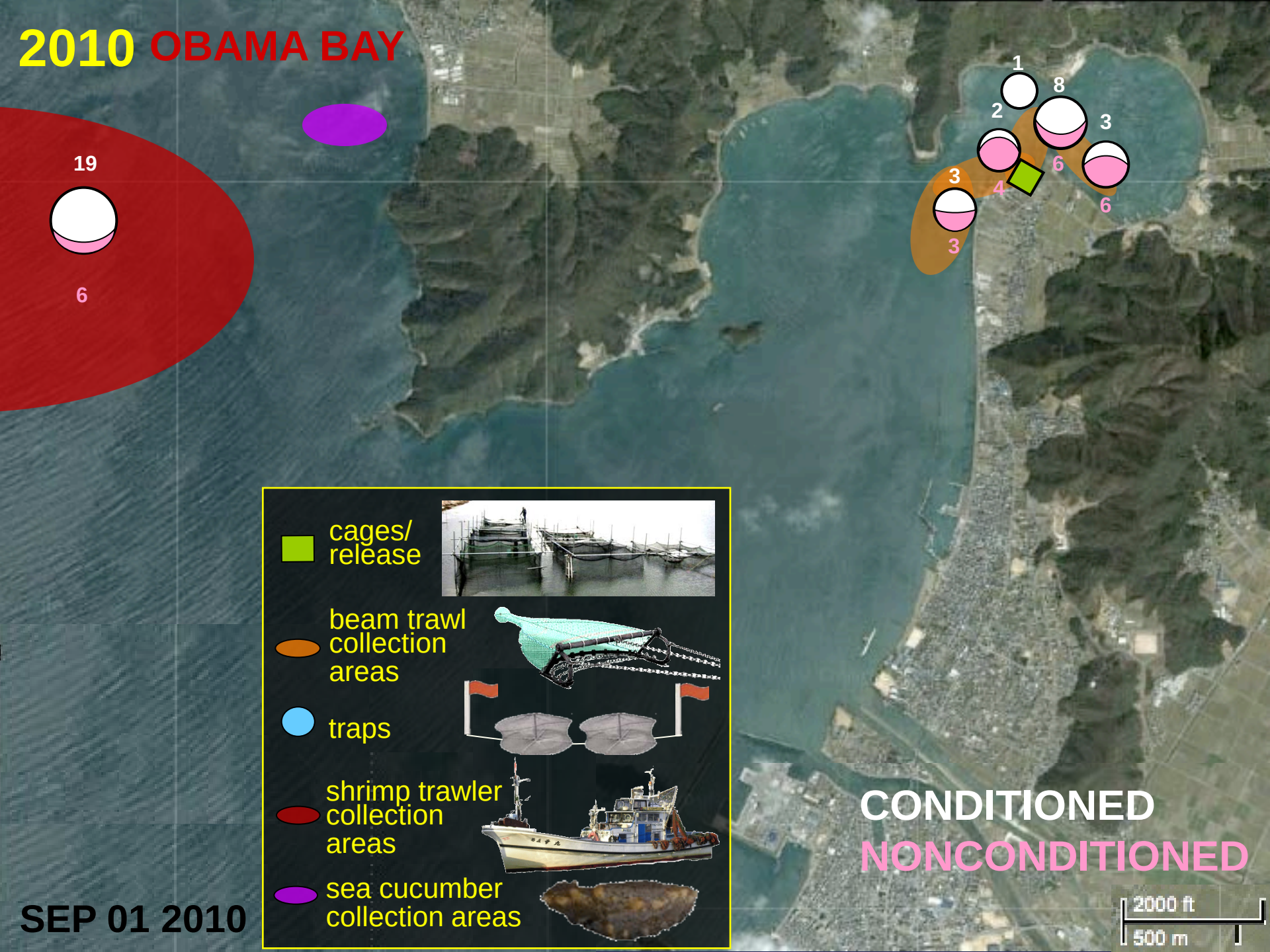
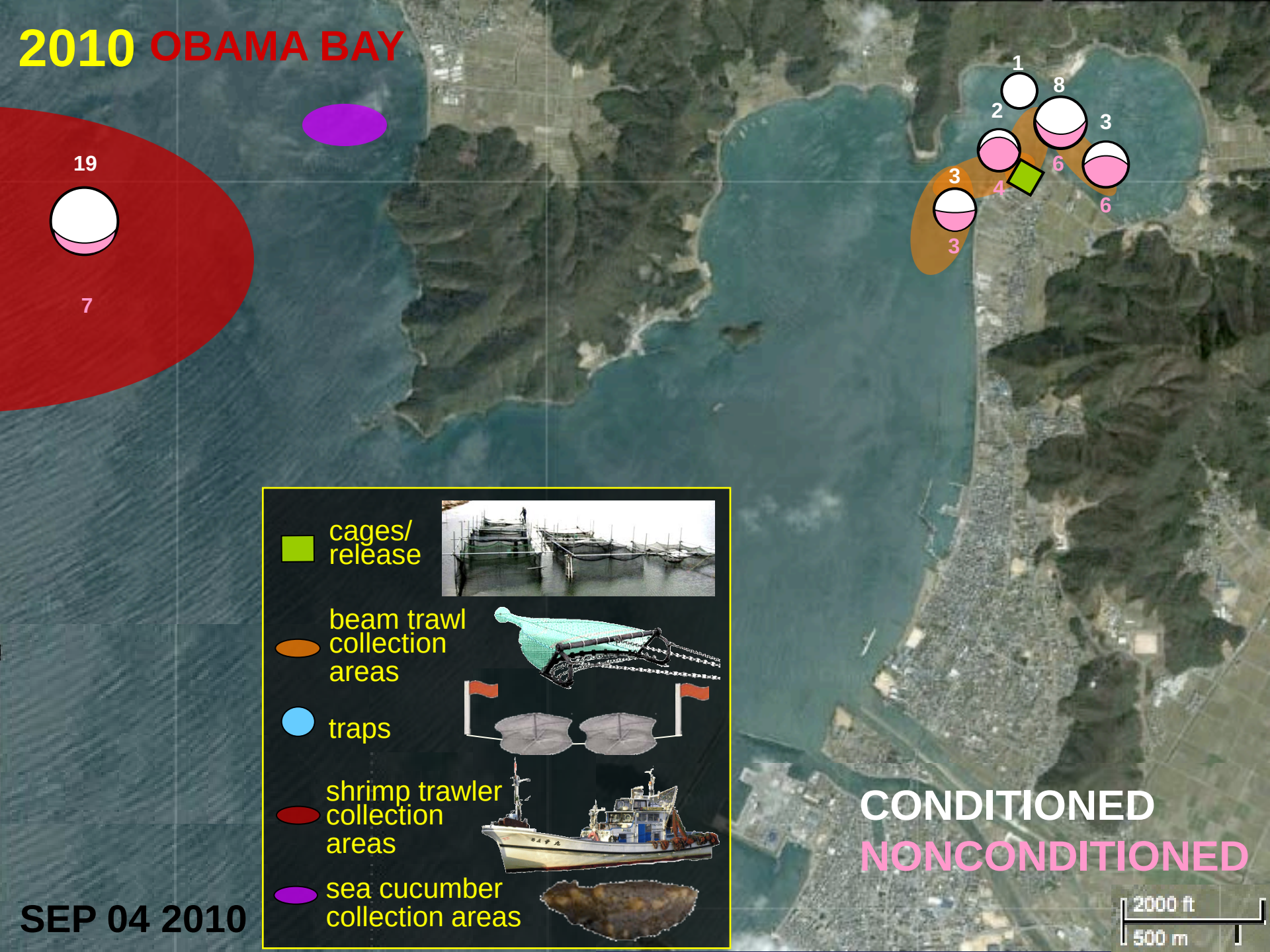
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
AUG 26 2010


2010 OBAMA BAY
19
6
1
8
2
3
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
SEP 01 2010


2010 OBAMA BAY
19
7
1
8
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6
3
4
6
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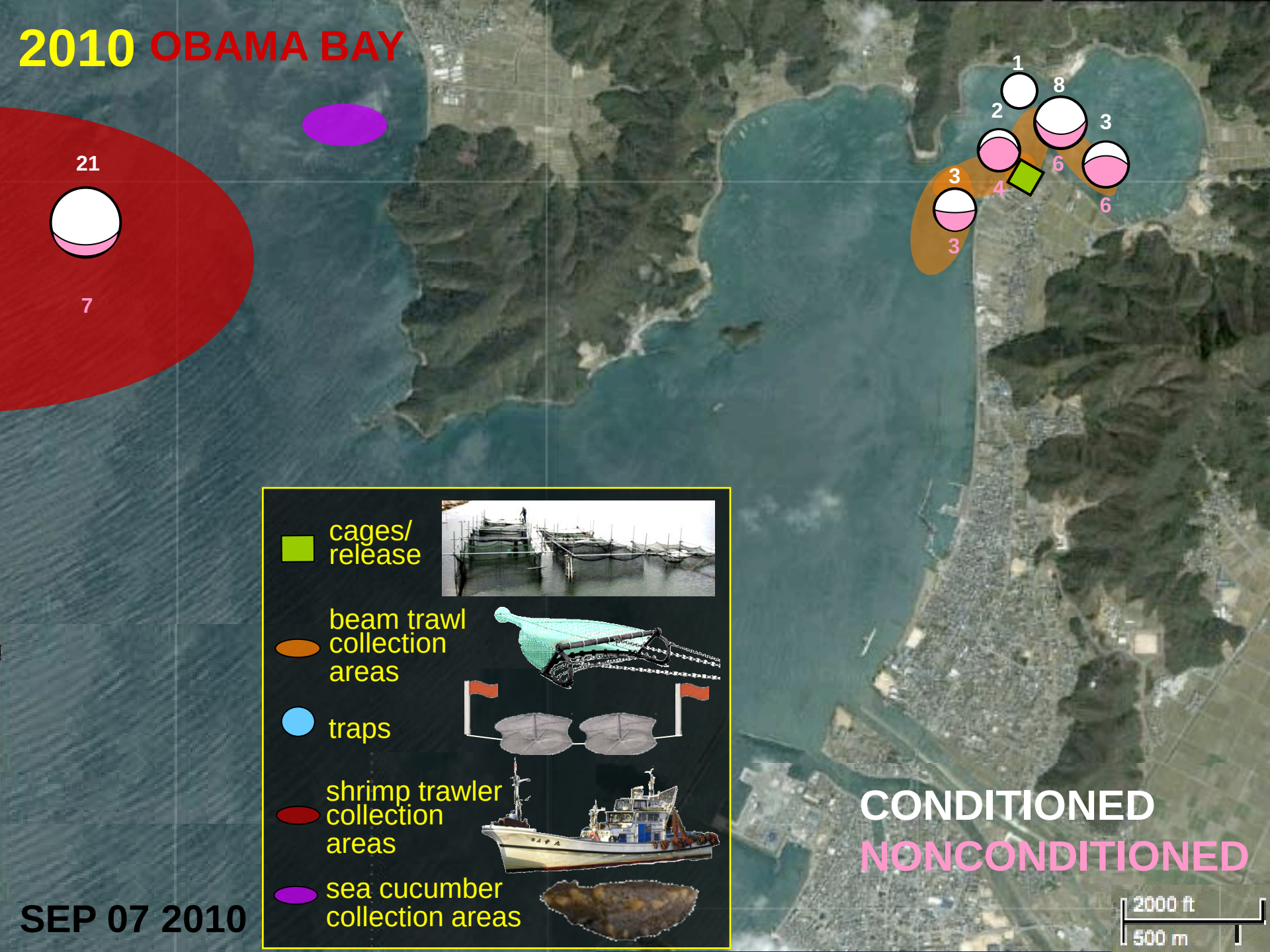
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
SEP 04 2010


2010 OBAMA BAY
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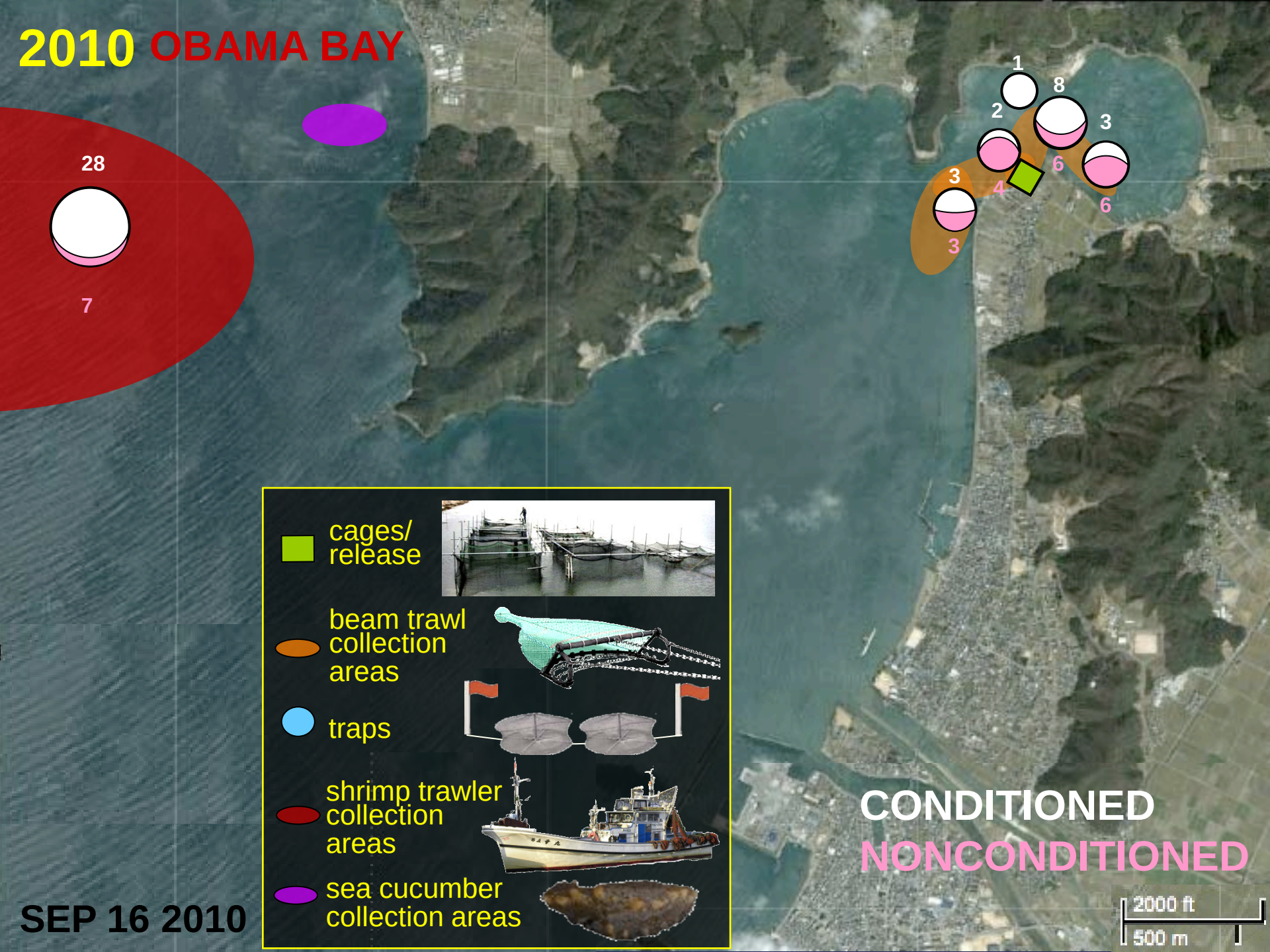
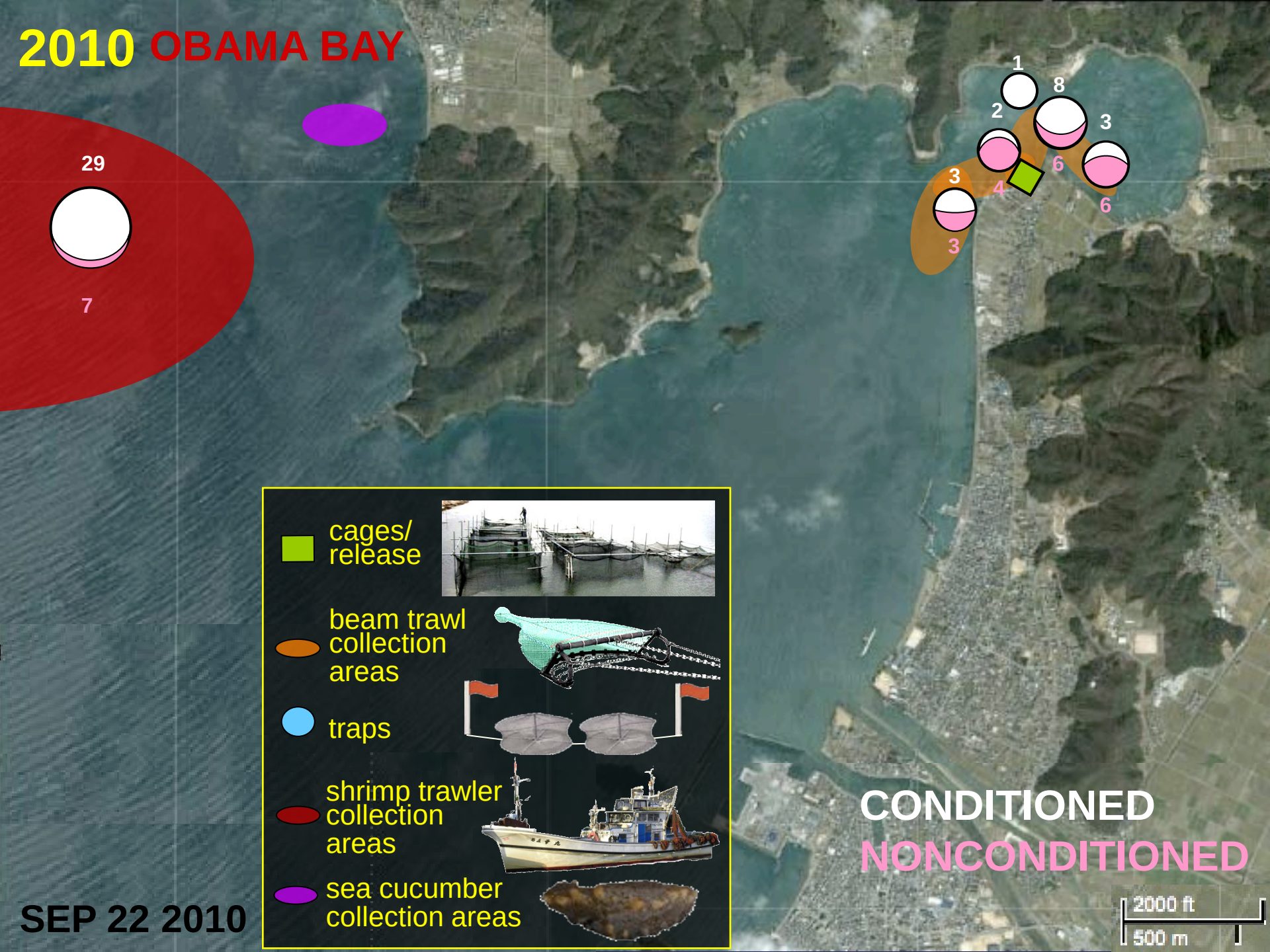
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
SEP 07 2010


2010 OBAMA BAY
28
7
1
8
2
3
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
SEP 16 2010


2010 OBAMA BAY
29
7
1
8
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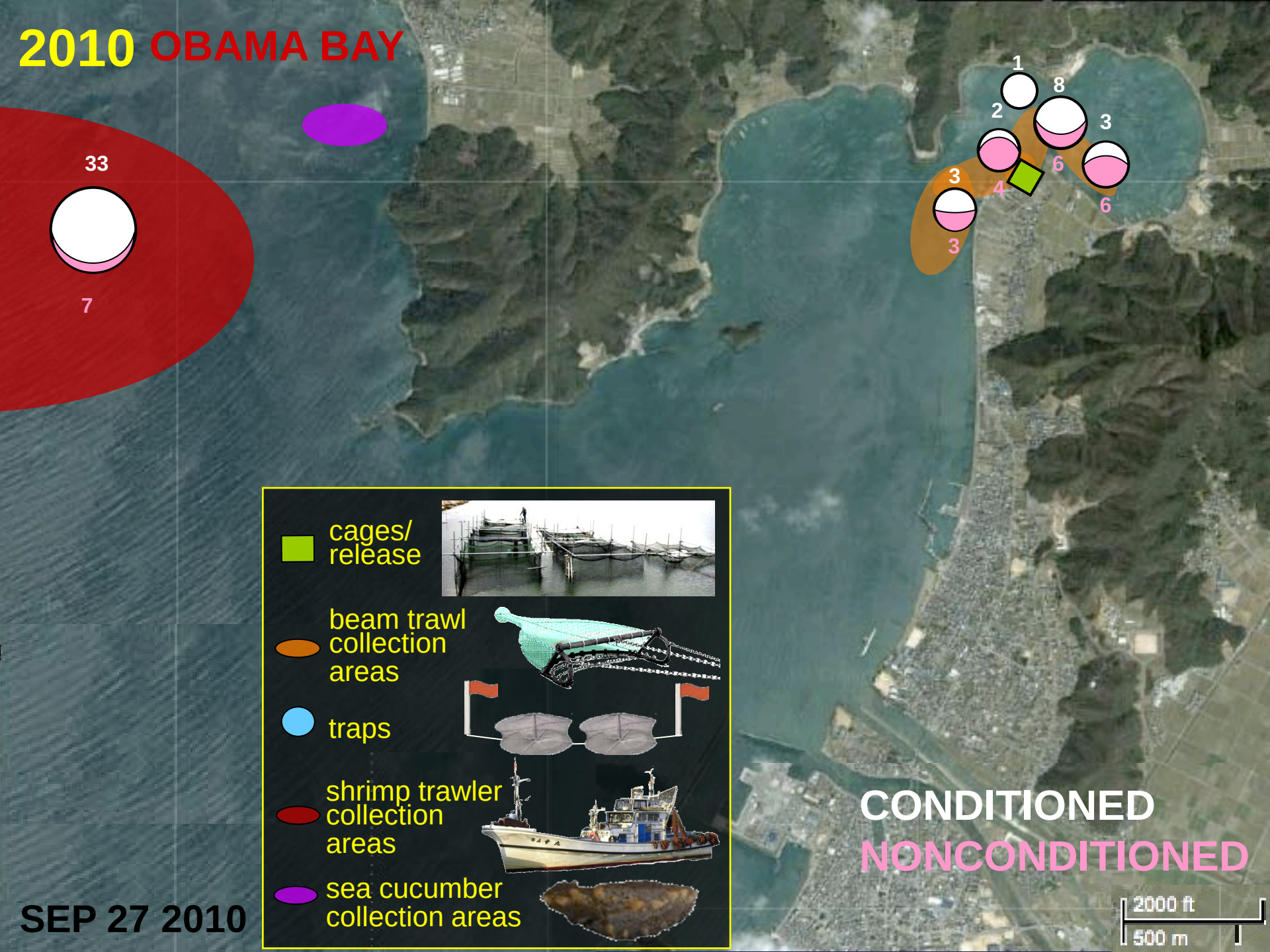
3
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
SEP 22 2010


2010 OBAMA BAY
33
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1
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2
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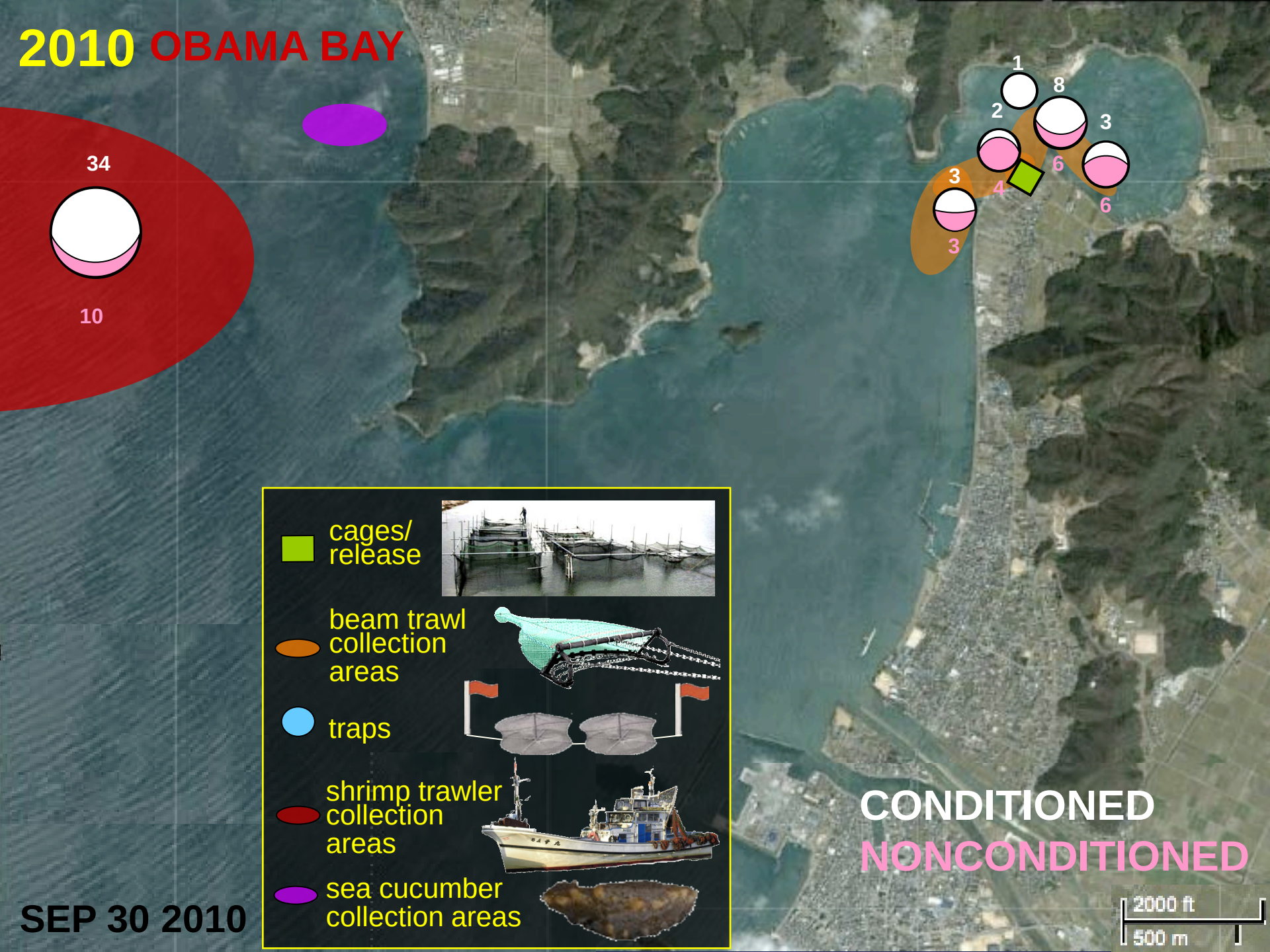
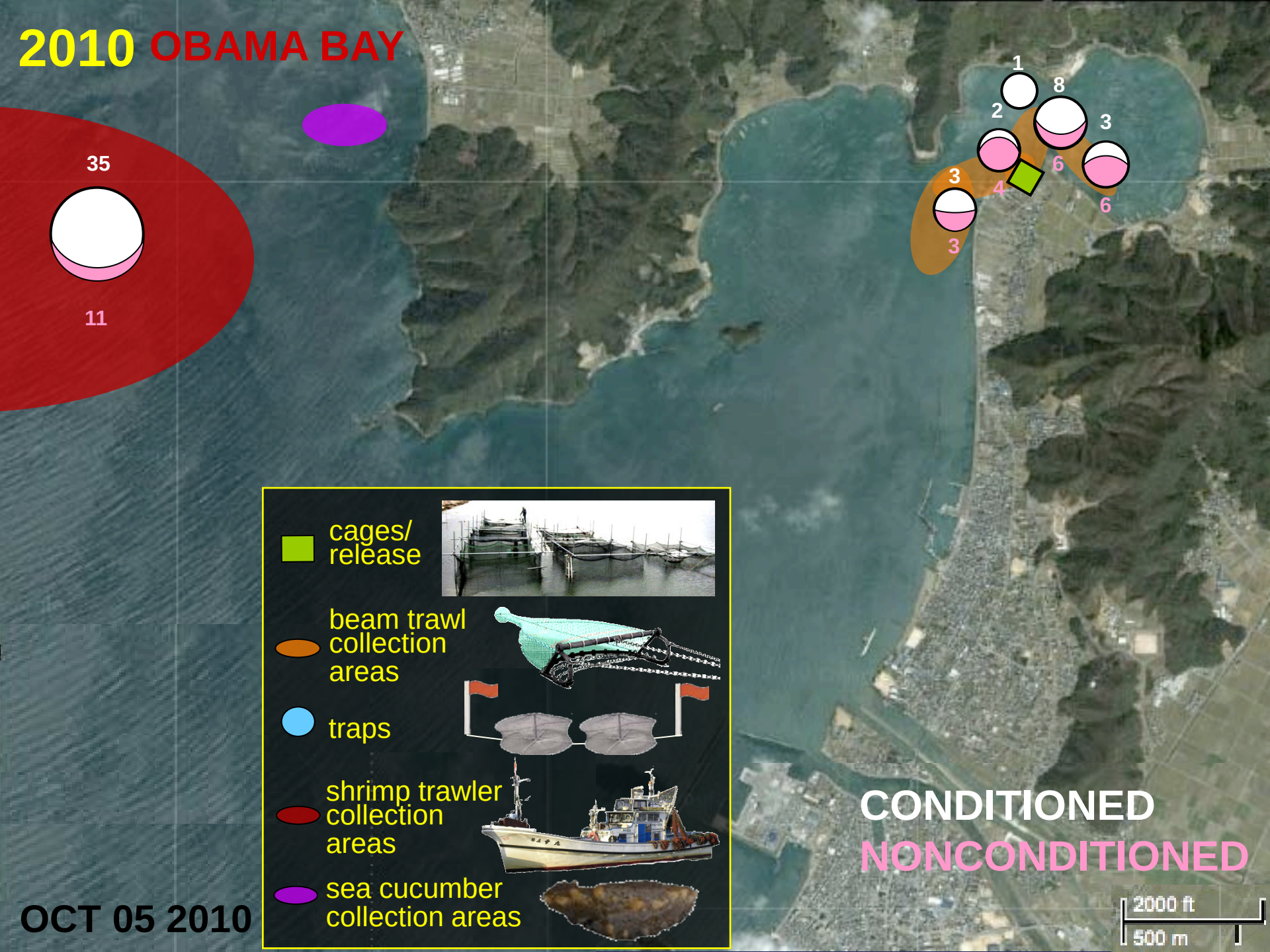
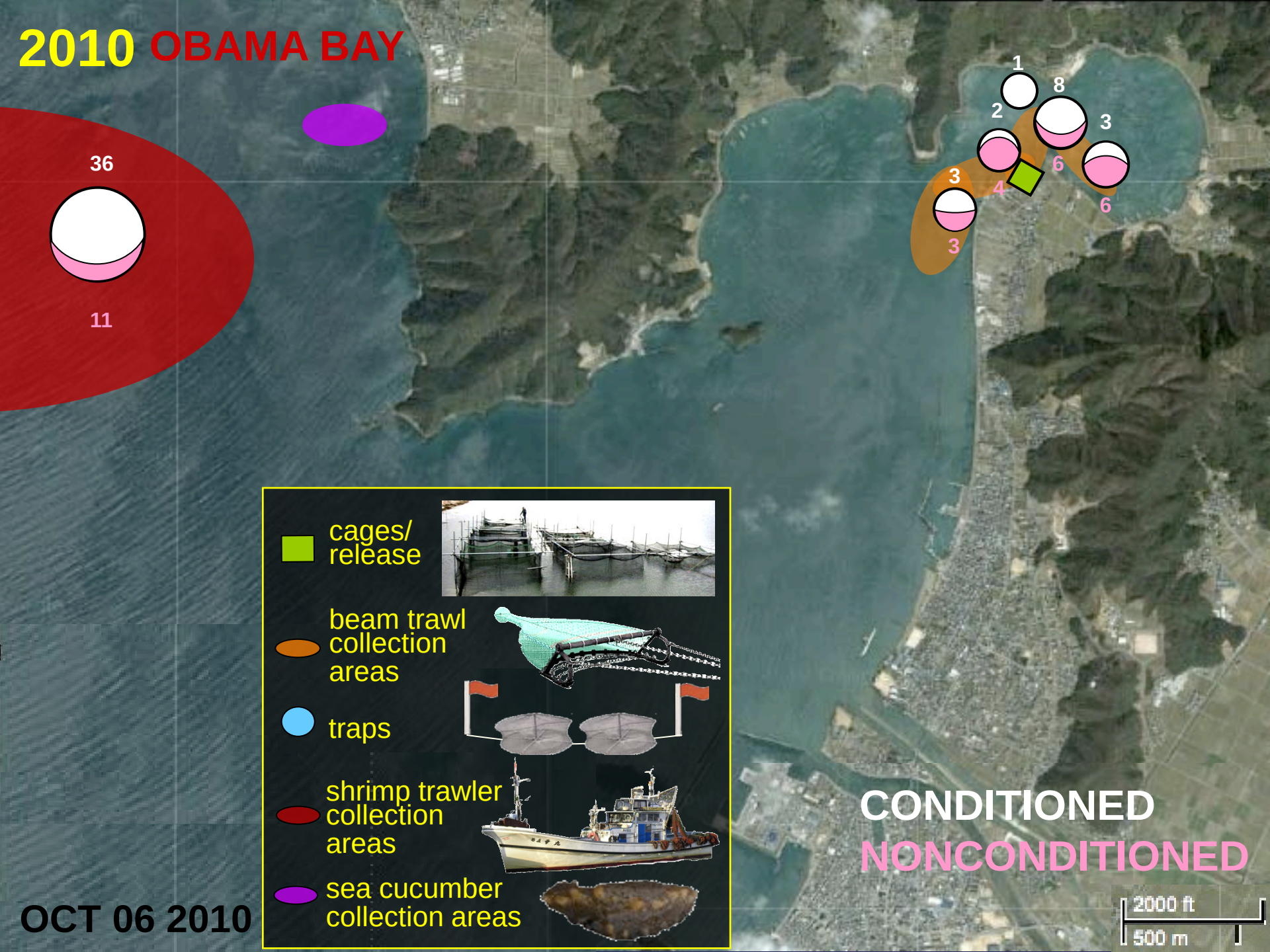
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
SEP 27 2010

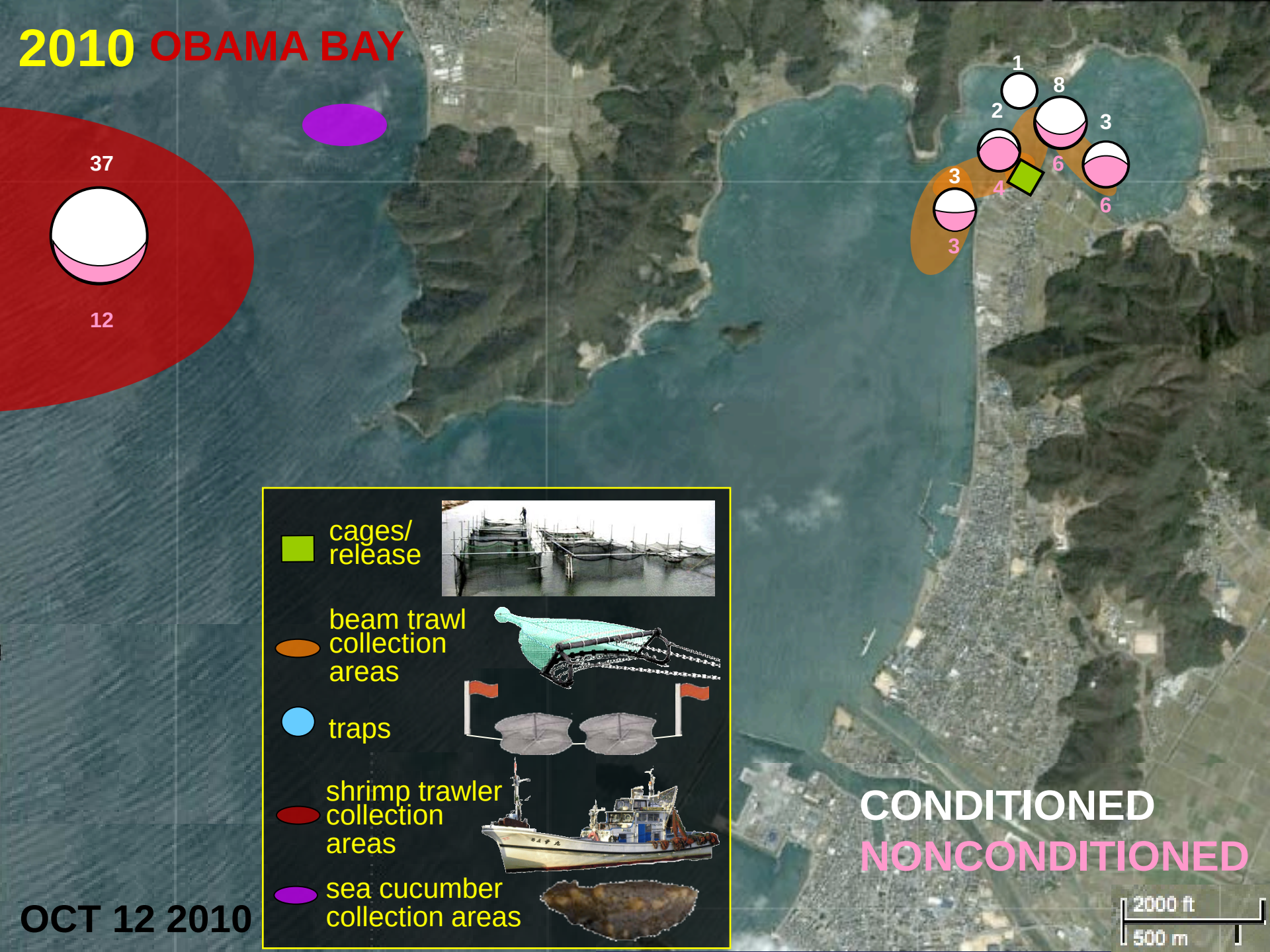

2010 OBAMA BAY
34
10
1
8
2
3
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
SEP 30 2010

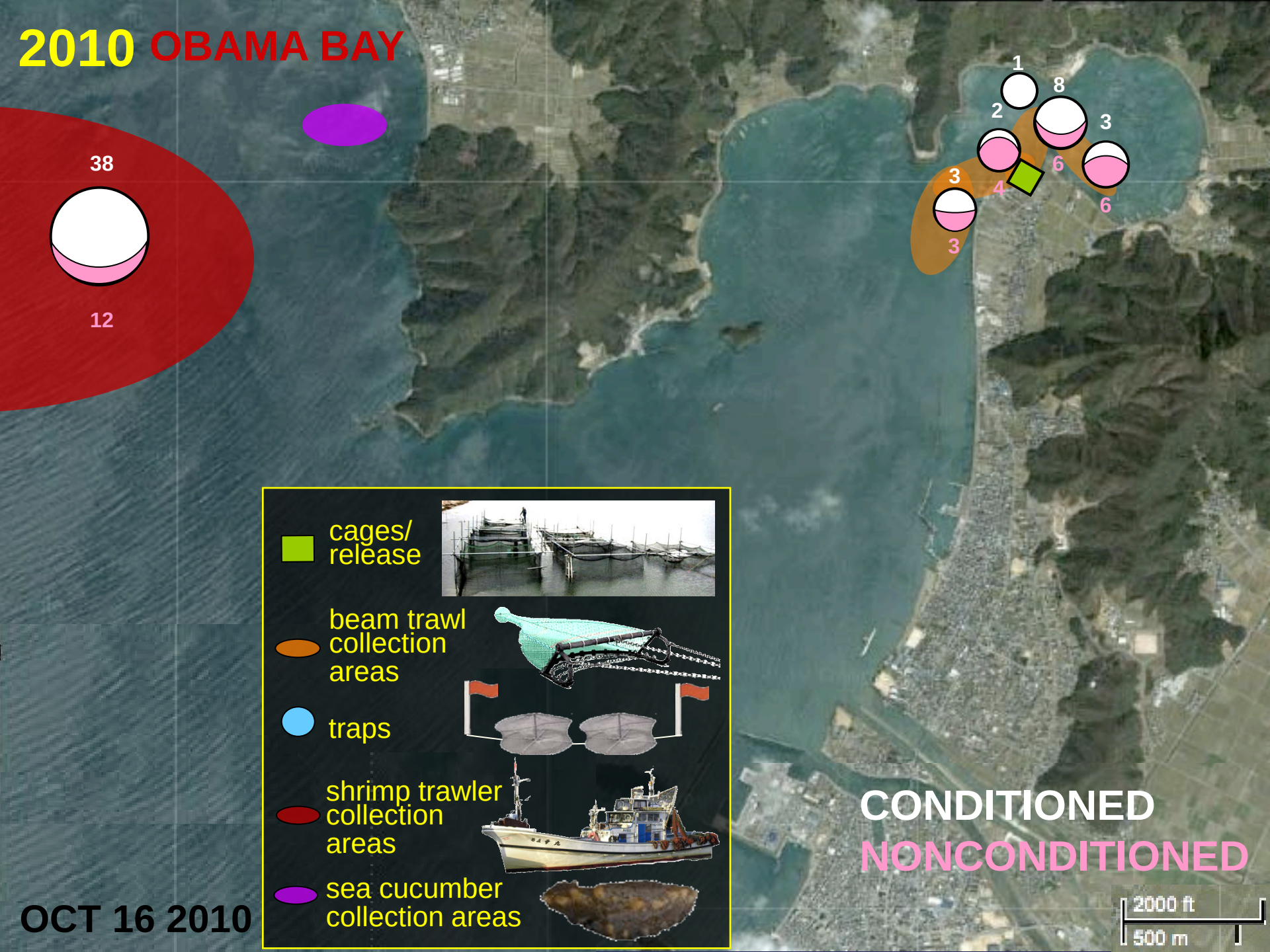

2010 OBAMA BAY
35
11
1
8
2
3
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
OCT 05 2010

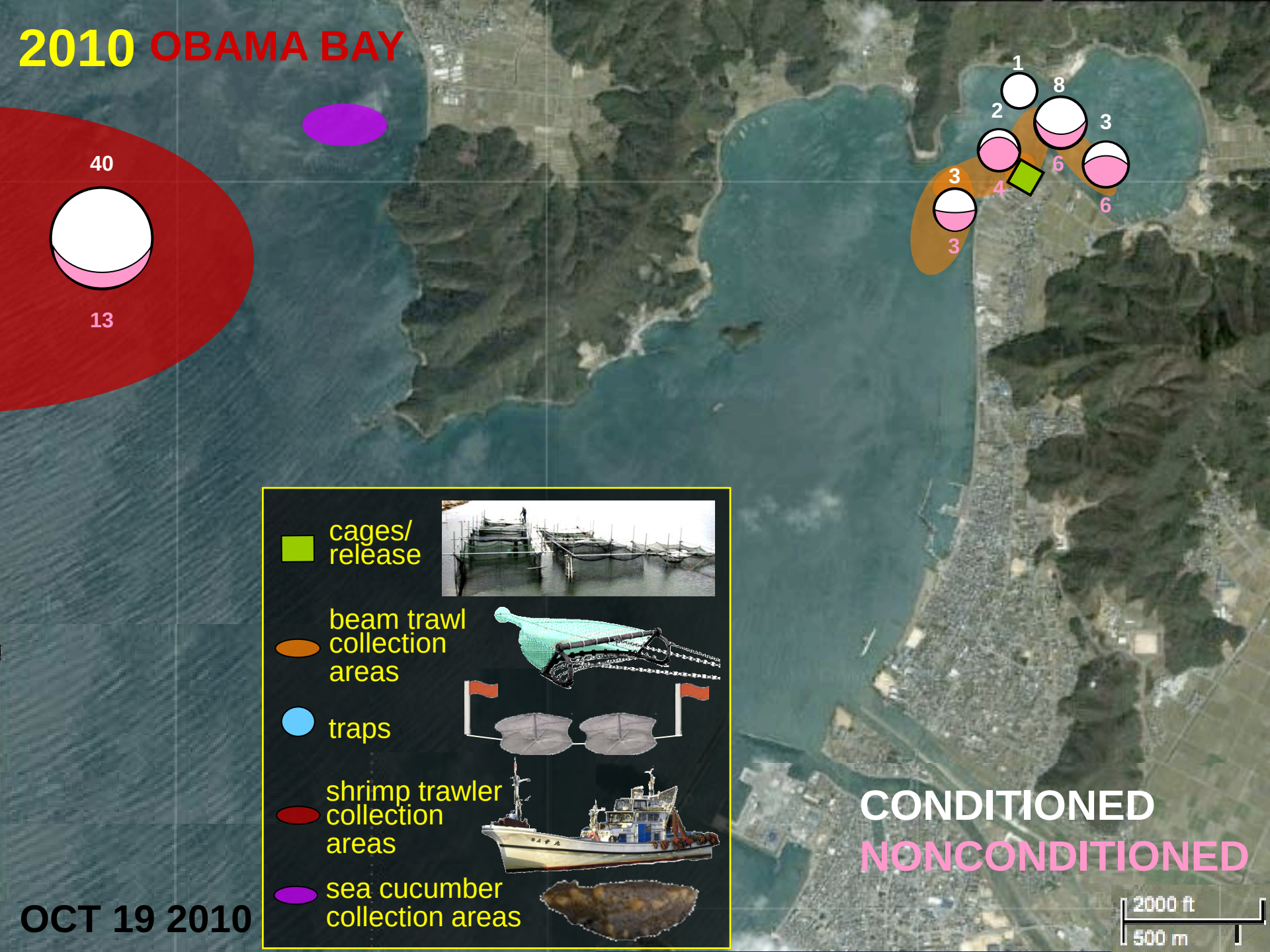
2010 OBAMA BAY



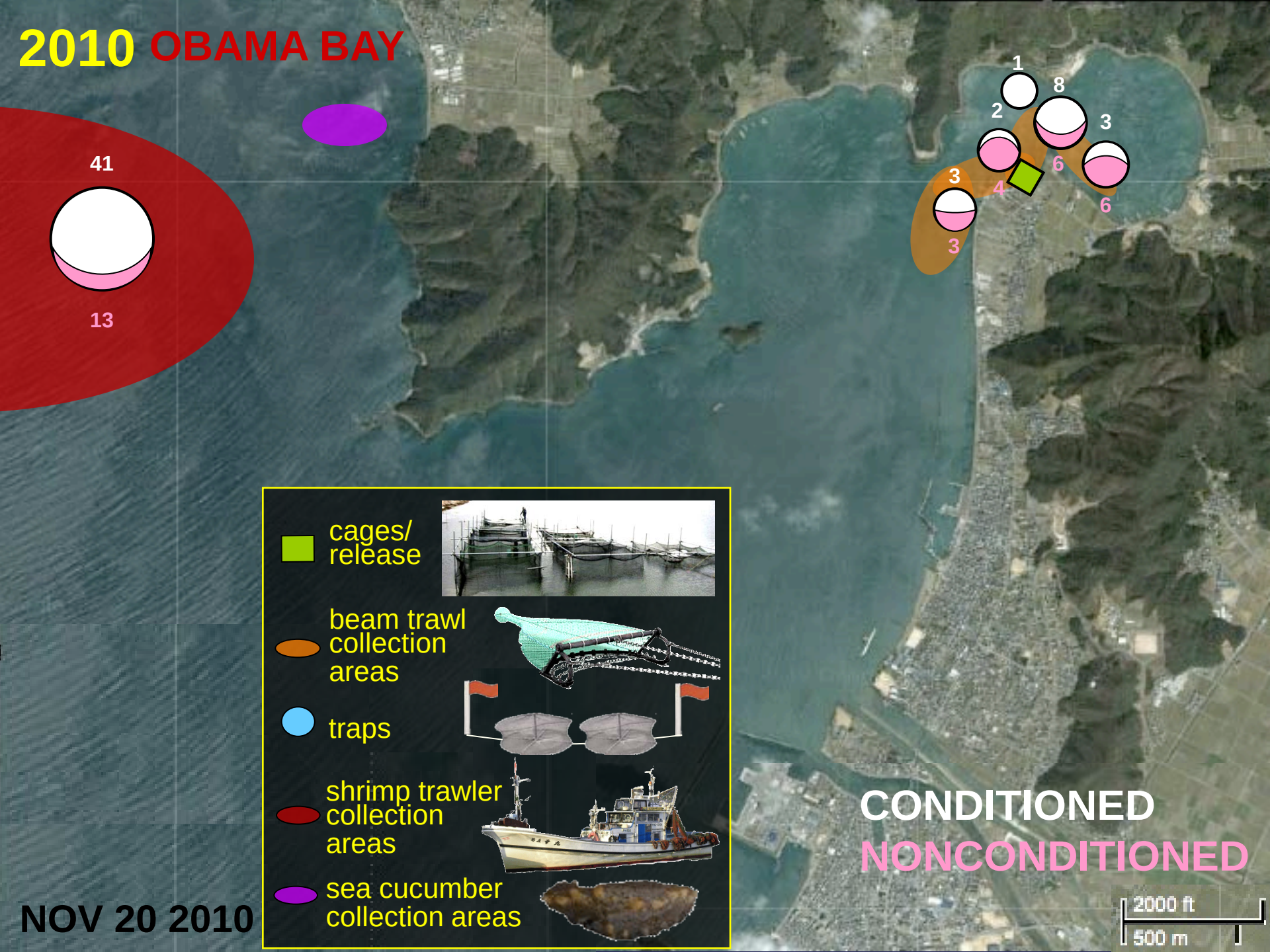
OCT 06 2010


2010 OBAMA BAY
37
12
1
8
2
3
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
OCT 12 2010


2010 OBAMA BAY
38
12
1
8
2
3
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
OCT 16 2010


2010 OBAMA BAY
40
13
1
8
2
3
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
OCT 19 2010

2010 OBAMA BAY



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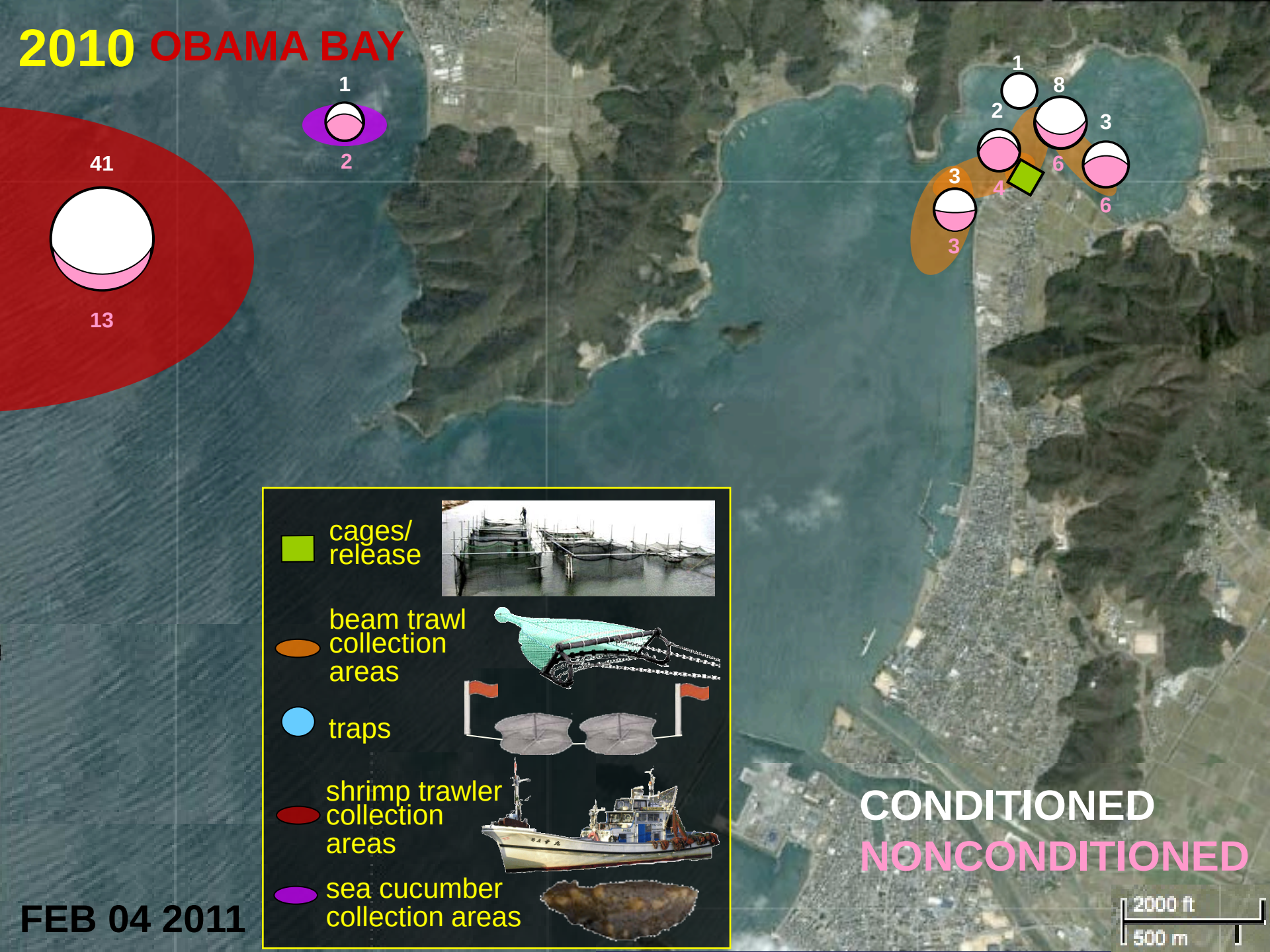
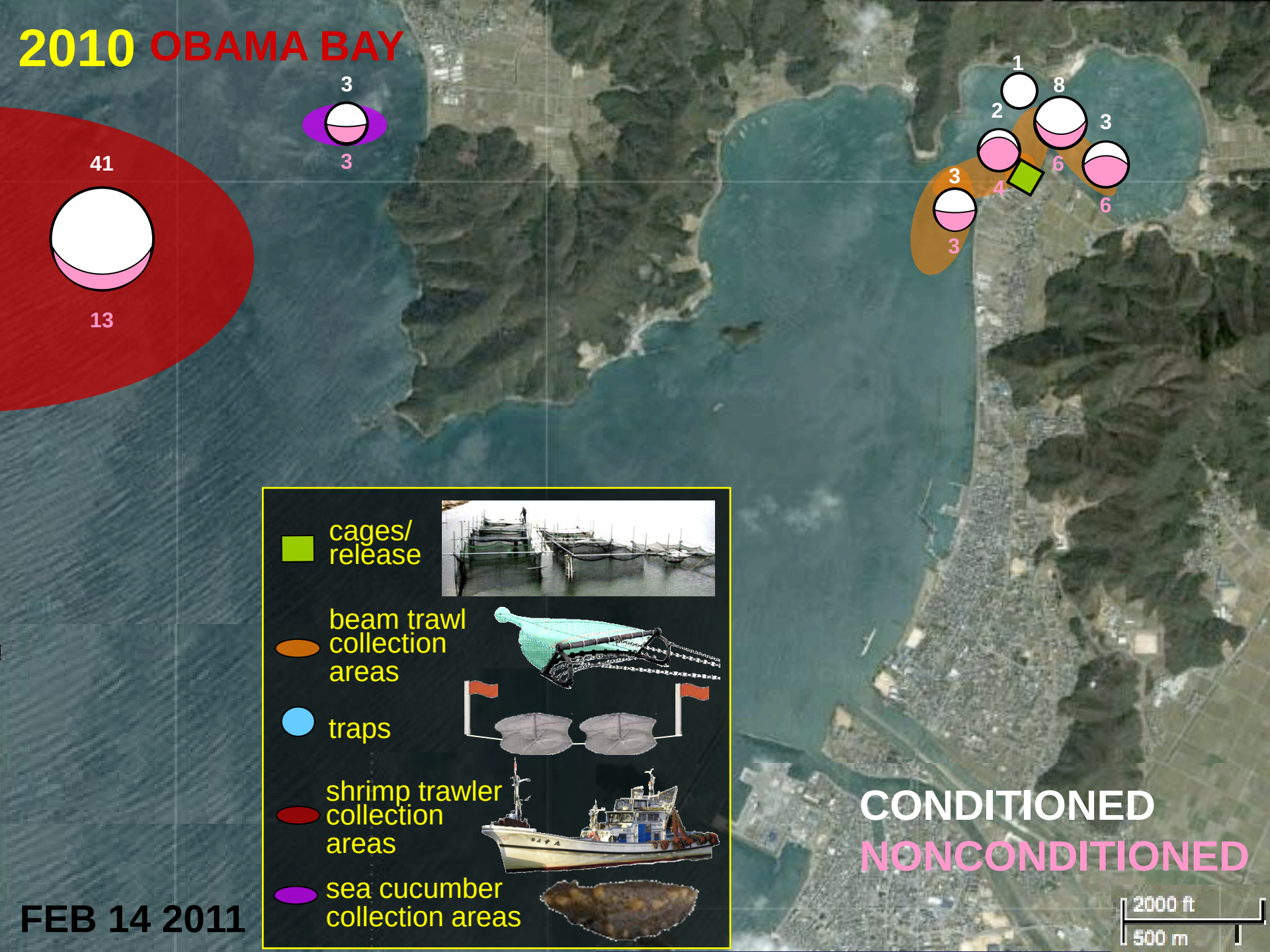
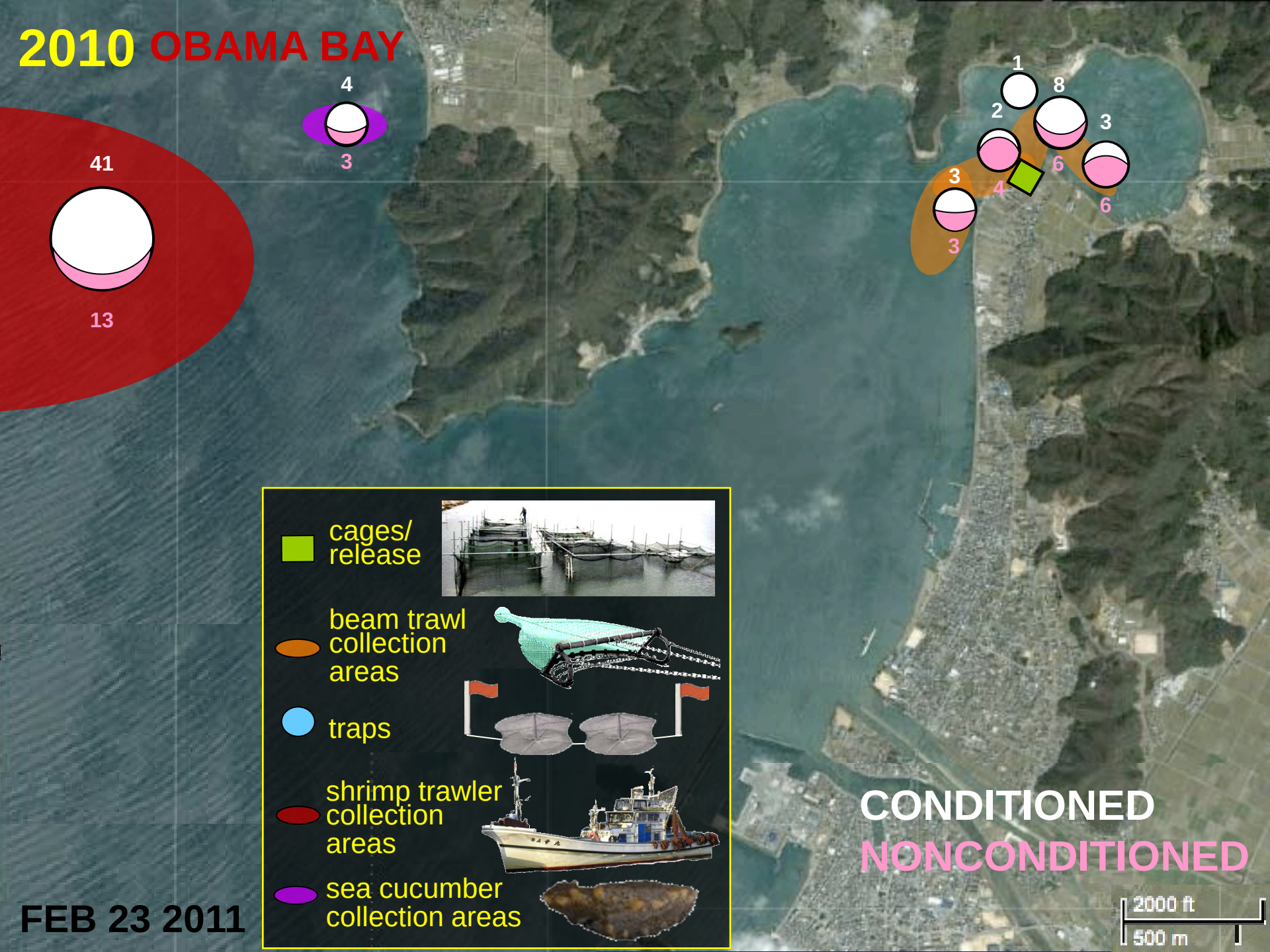

2010 OBAMA BAY
41
13
1
2
1
8
2
3
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
FEB 04 2011

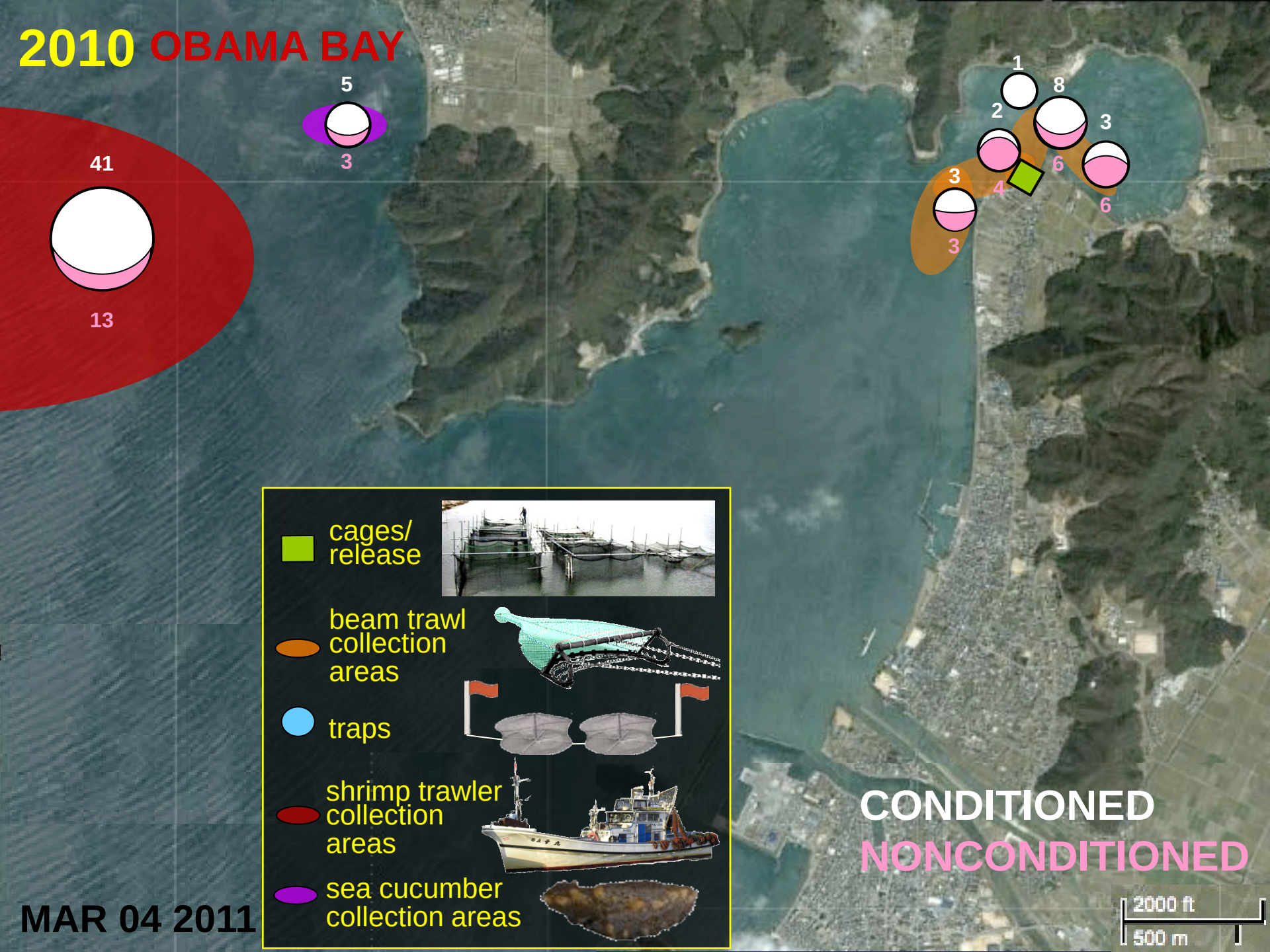
2010 OBAMA BAY



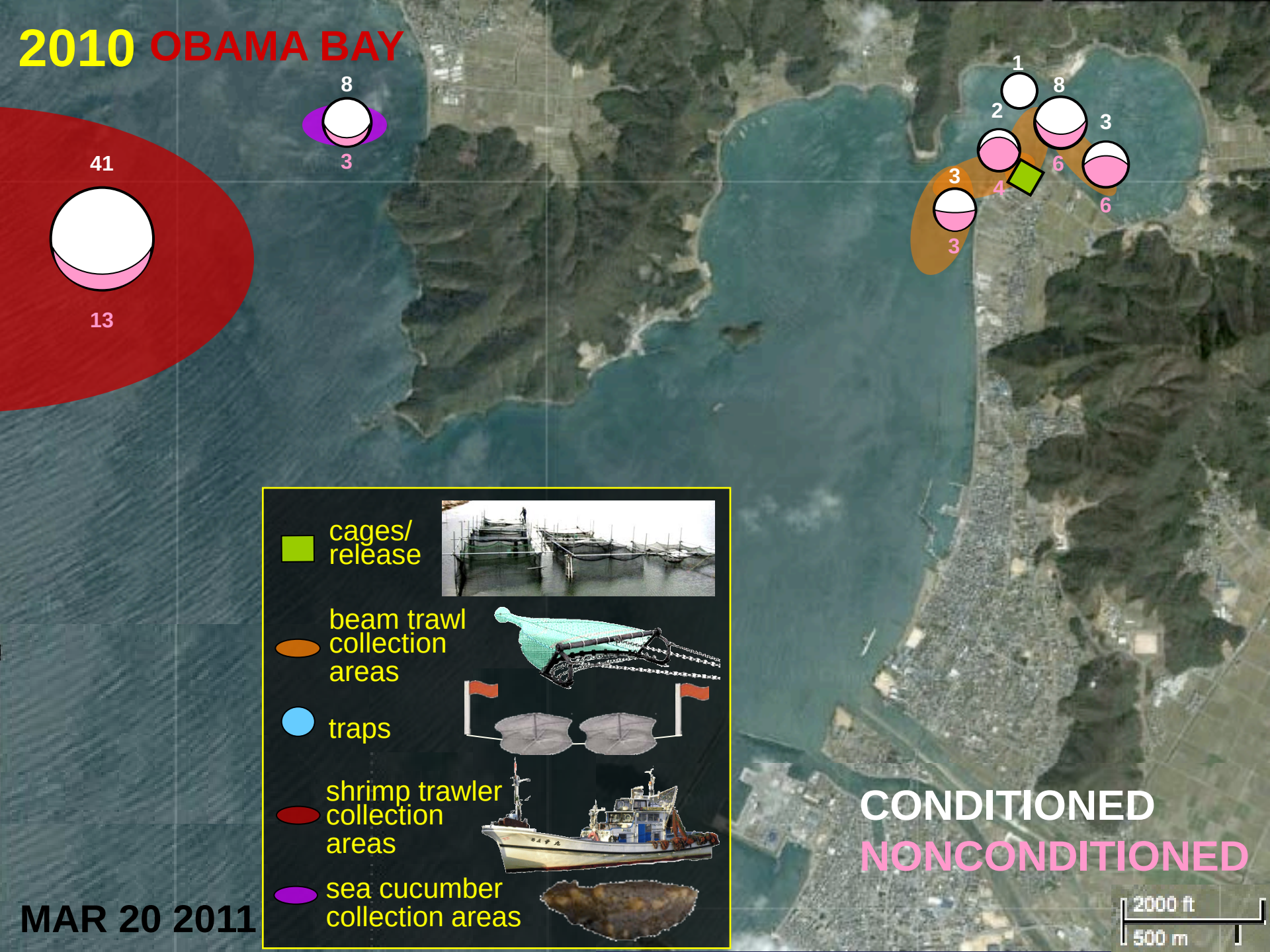
FEB 14 2011

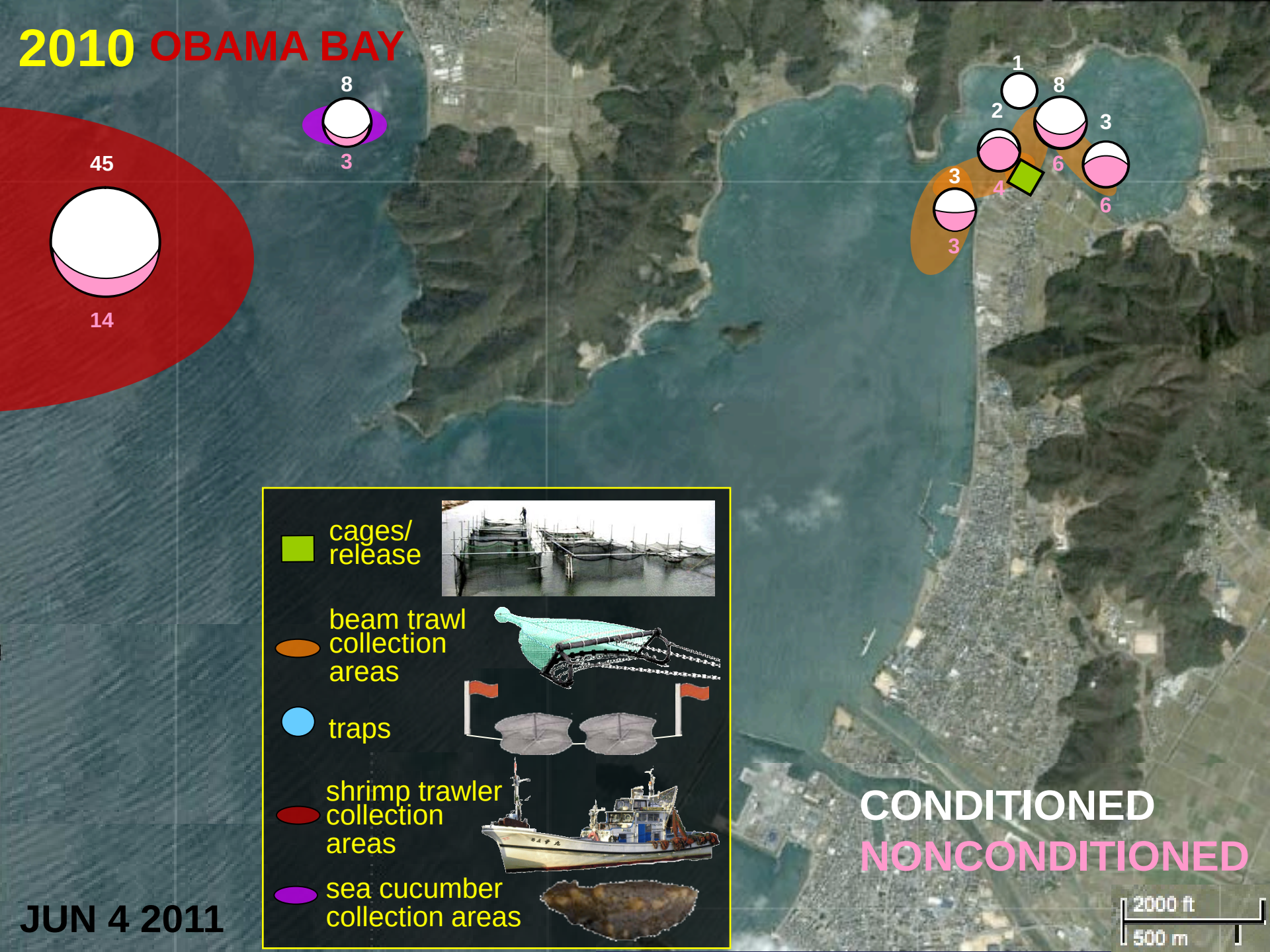

2010 OBAMA BAY
41
13
4
3
1
8
2
3
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
FEB 23 2011

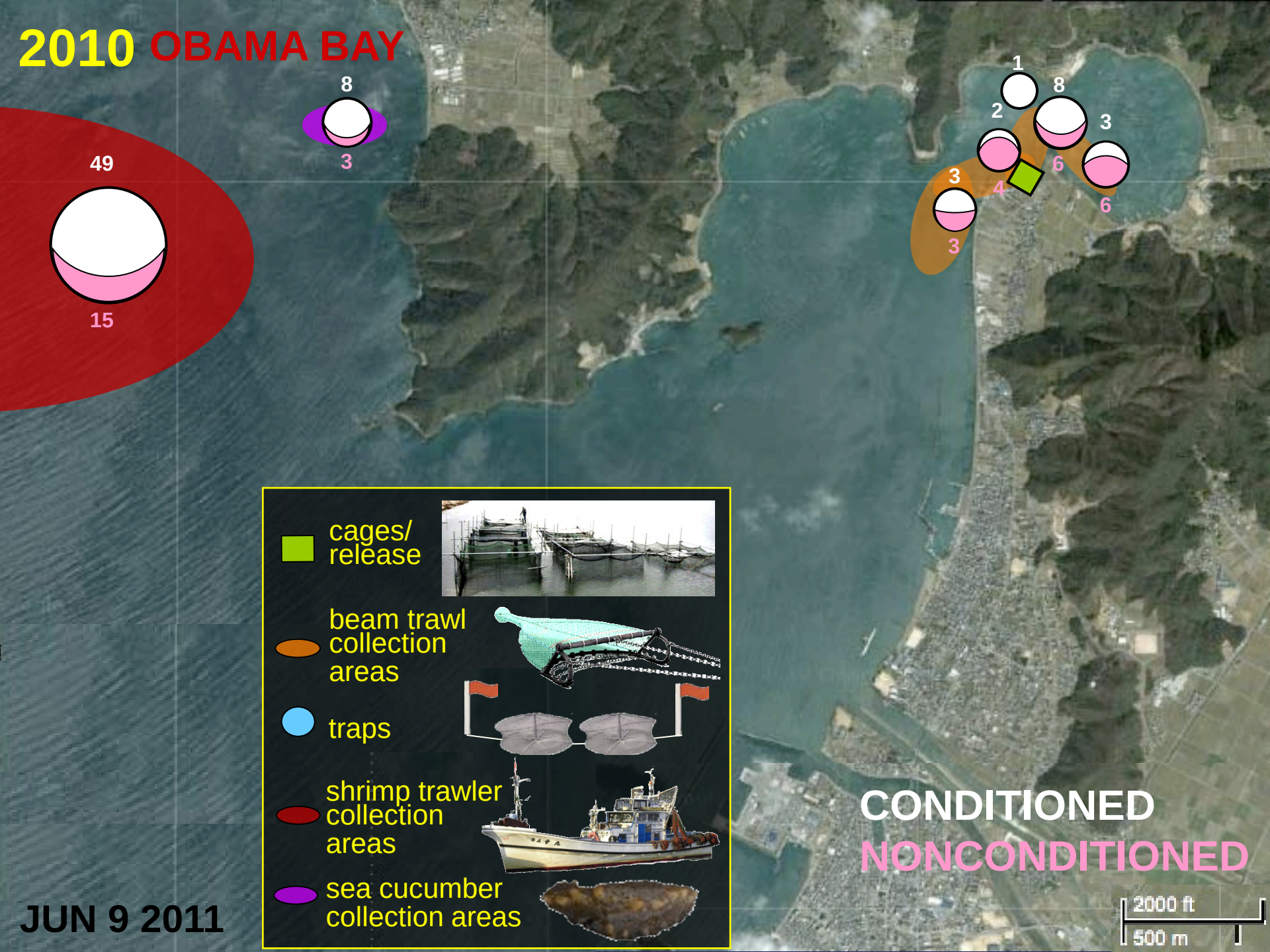
2010 OBAMA BAY

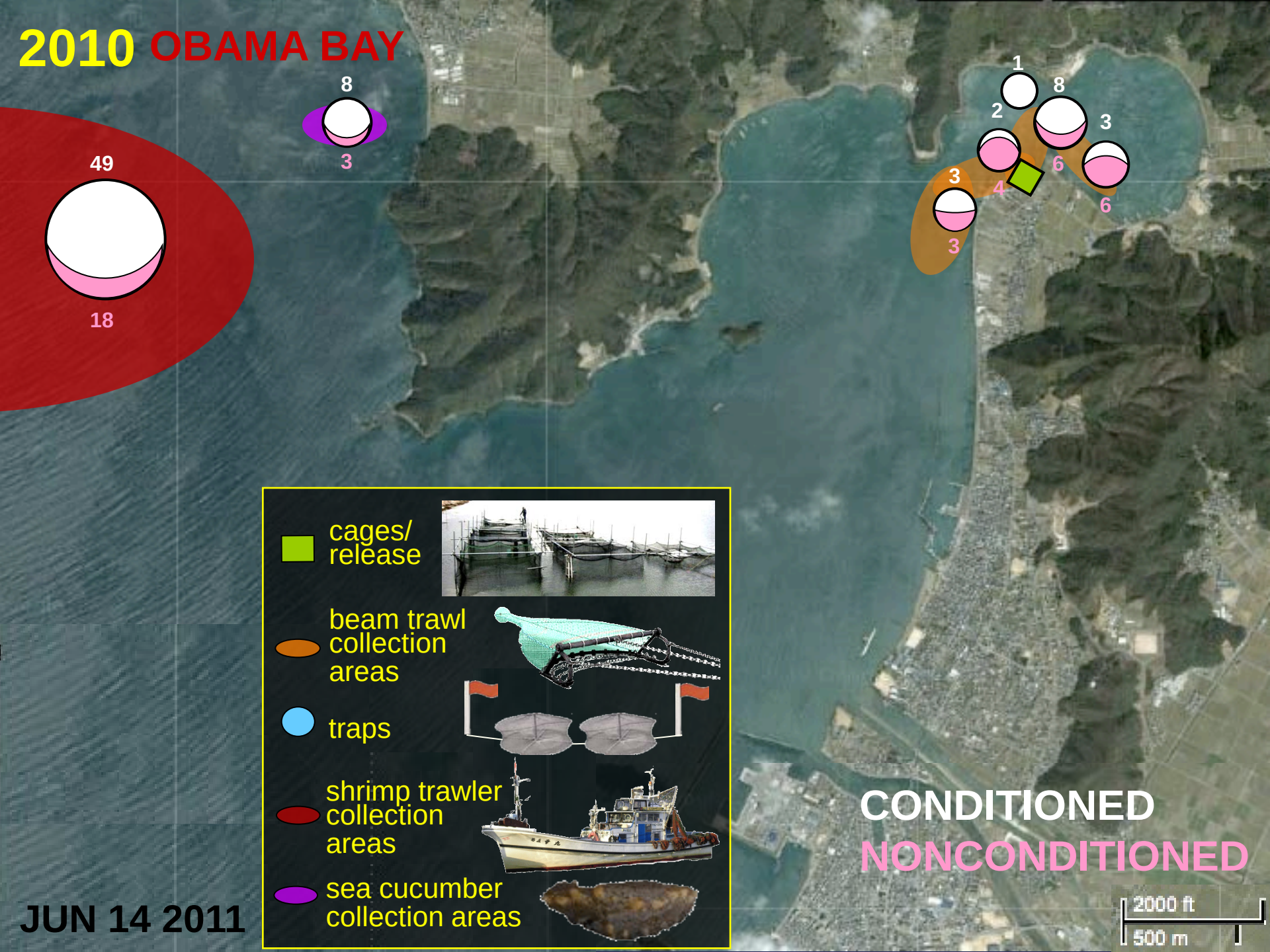


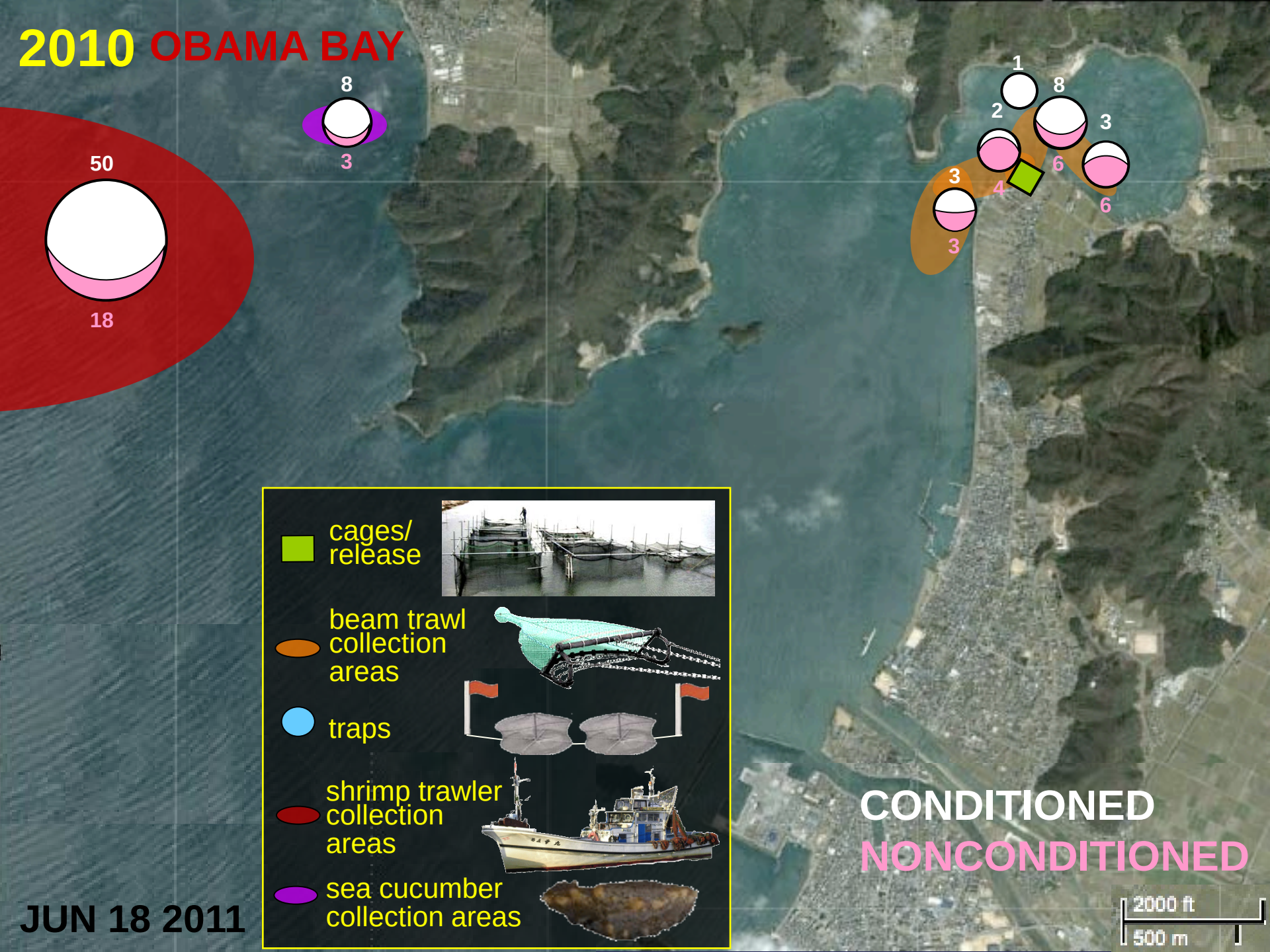
MAR 04 2011

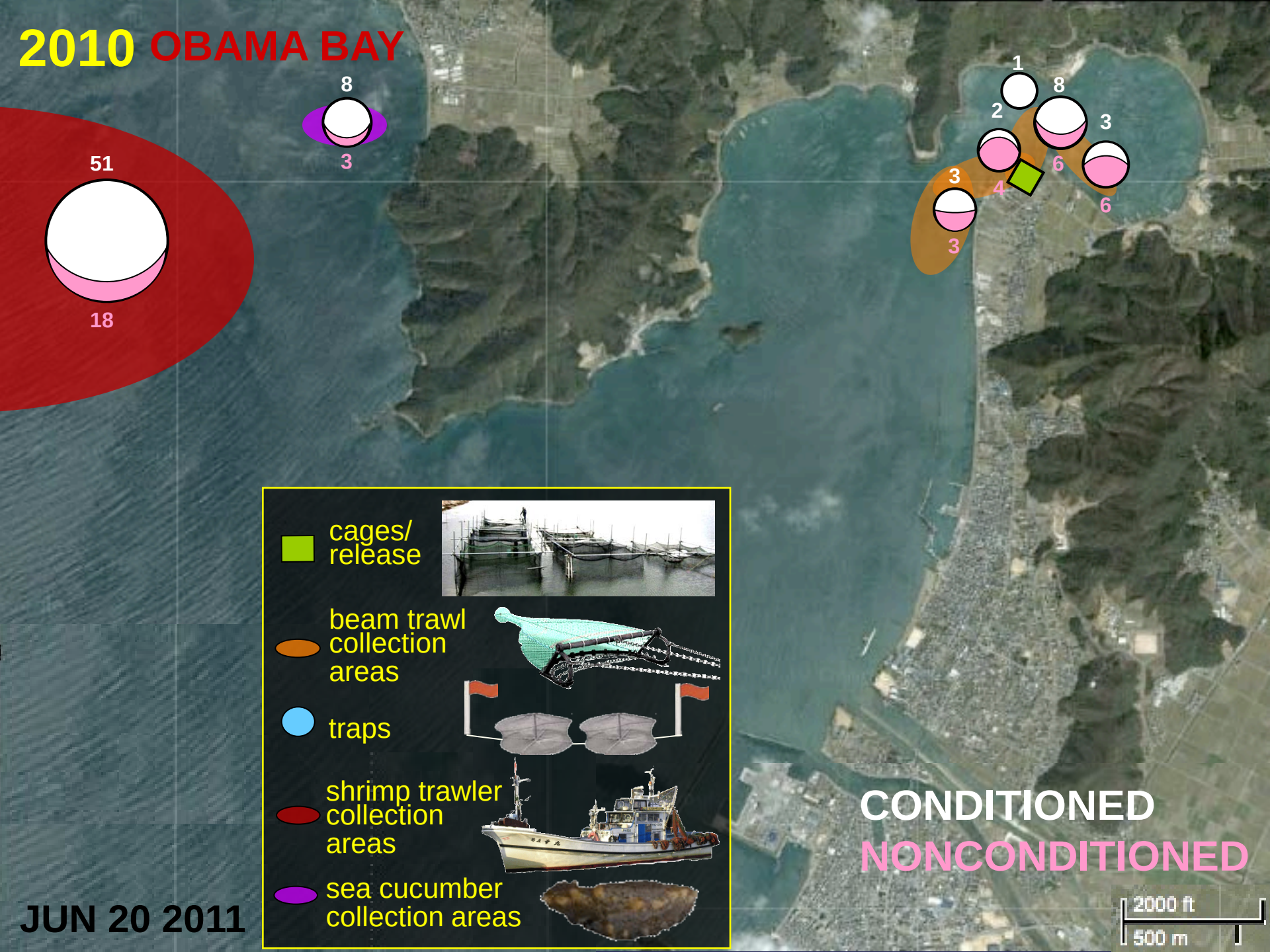

2010 OBAMA BAY
41
13
8
3
1
8
2
3
3
6
4
6
3
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
MAR 20 2011


2010 OBAMA BAY
45
14
8
3
1
8
2
3
3
4
6
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUN 4 2011


2010 OBAMA BAY
49
15
8
3
1
8
2
3
3
6
4
6
3
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUN 9 2011


2010 OBAMA BAY
49
18
8
3
1
8
2
3
3
4
6
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUN 14 2011


2010 OBAMA BAY
50
18
8
3
1
8
2
3
6
3
4
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUN 18 2011


2010 OBAMA BAY
51
18
8
3
1
8
2
3
3
6
4
6
3
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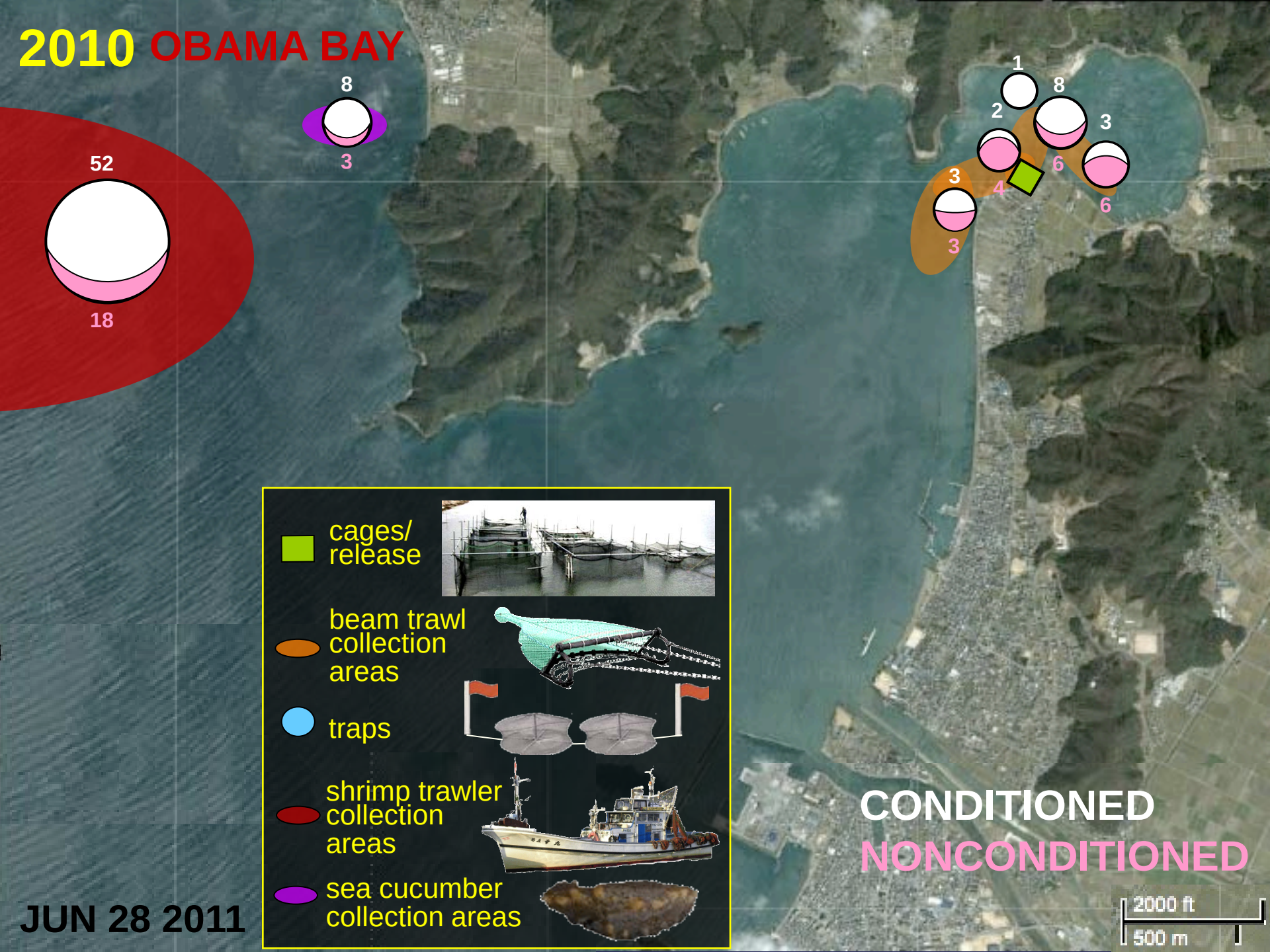
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUN 20 2011


2010 OBAMA BAY
52
18
8
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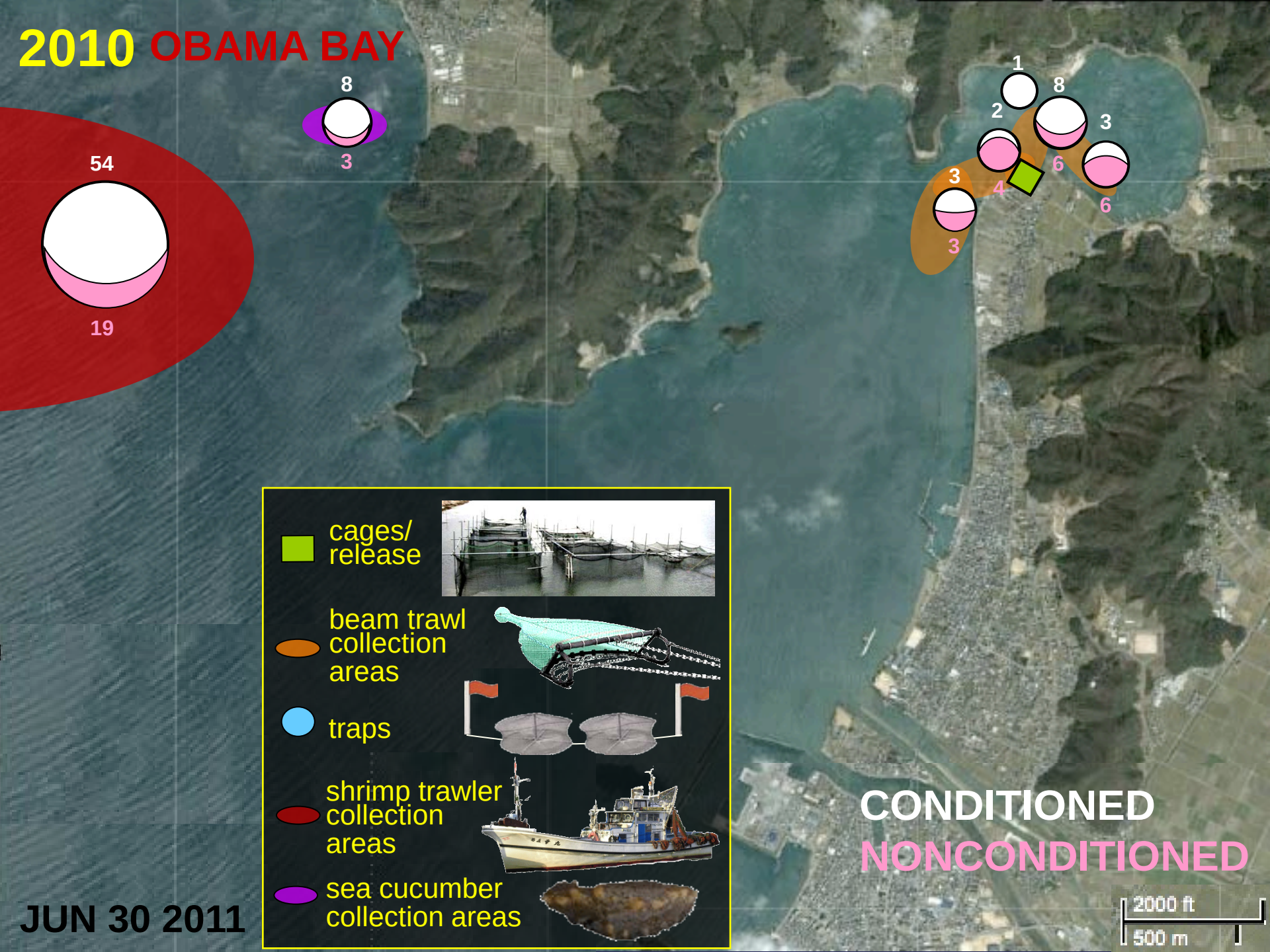
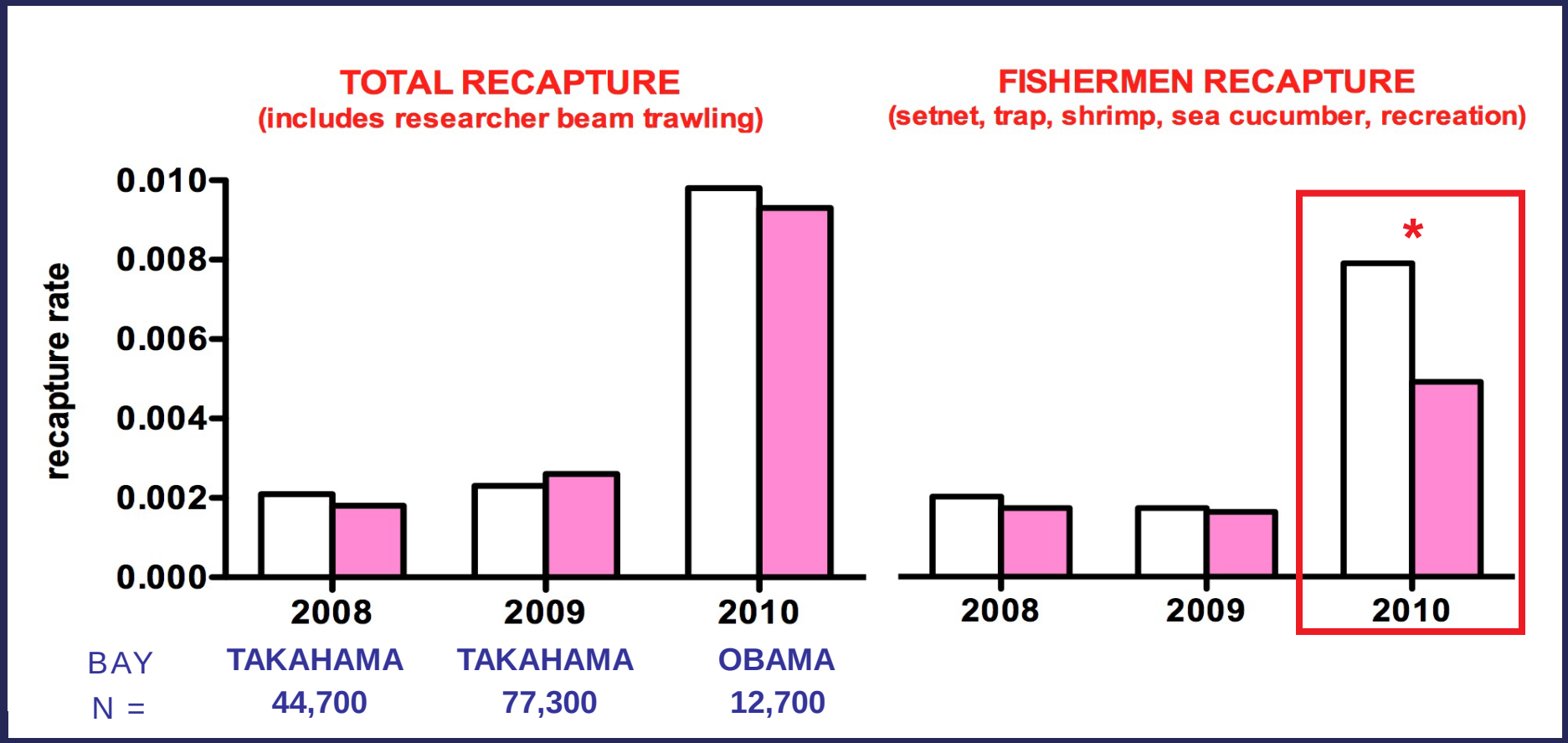
1
8
2
3
3
6
4
6
3
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUN 28 2011


2010 OBAMA BAY
54
19
8
3
1
8
2
3
3
4
6
6
3
cages/ release
beam trawl collection areas
traps
shrimp trawler collection areas
sea cucumber collection areas
CONDITIONED
NONCONDITIONED
2000 ft
500 m
JUN 30 2011

Recapture rates

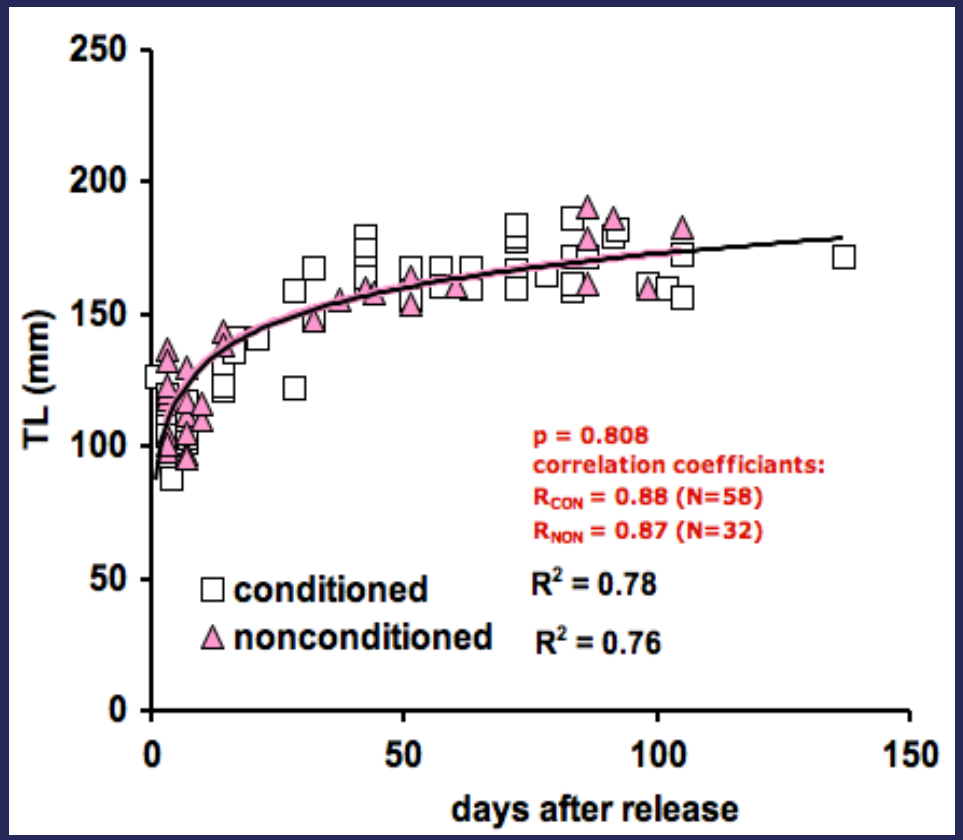


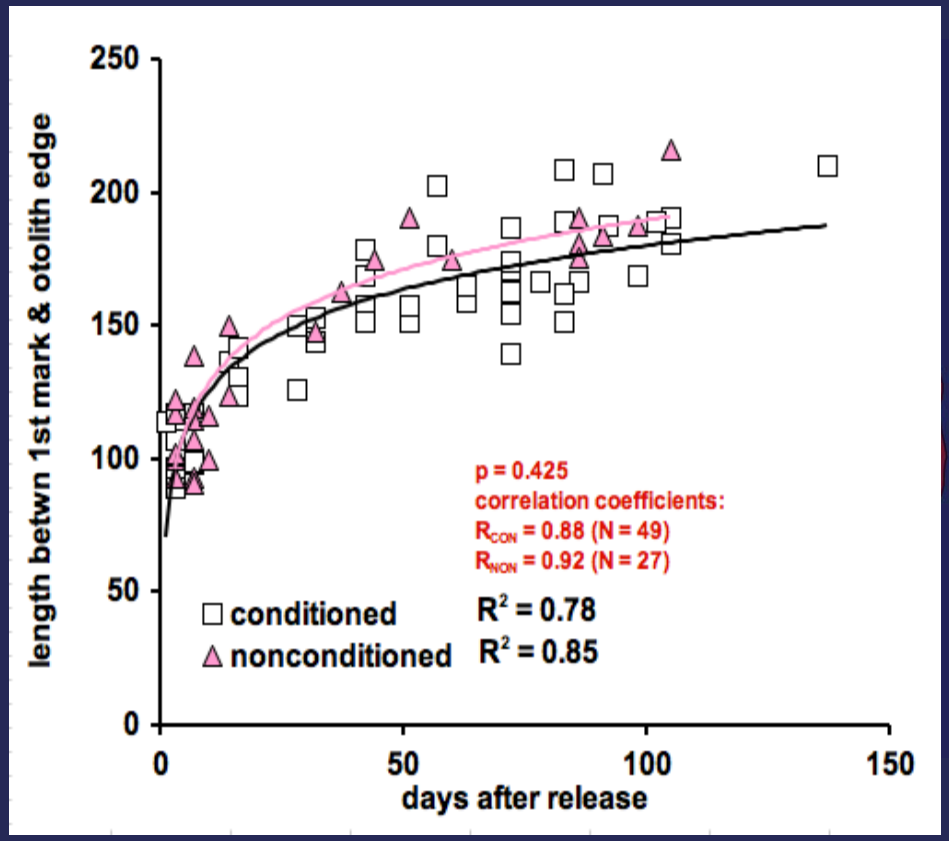
□ conditioned

▲ nonconditioned

chi square
*p < 0.05

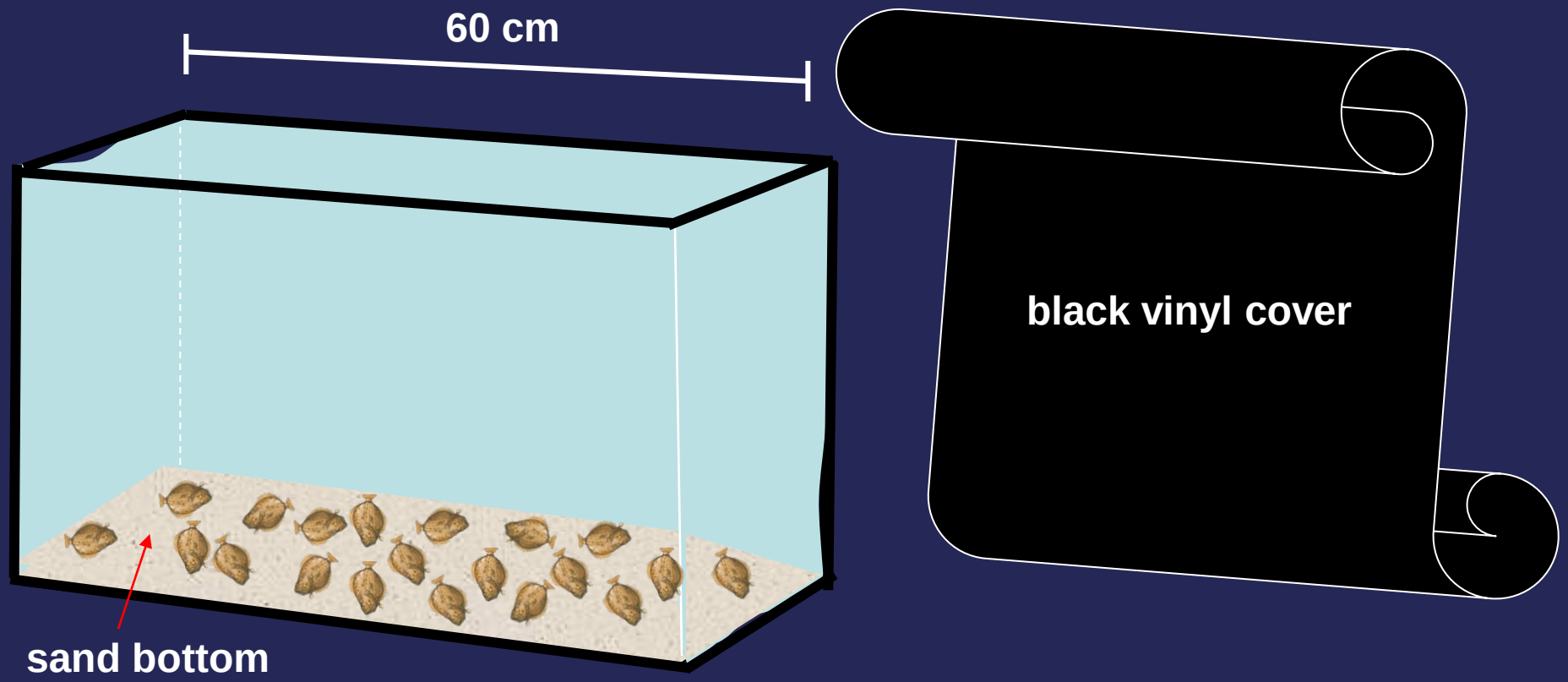
Growth (2010)





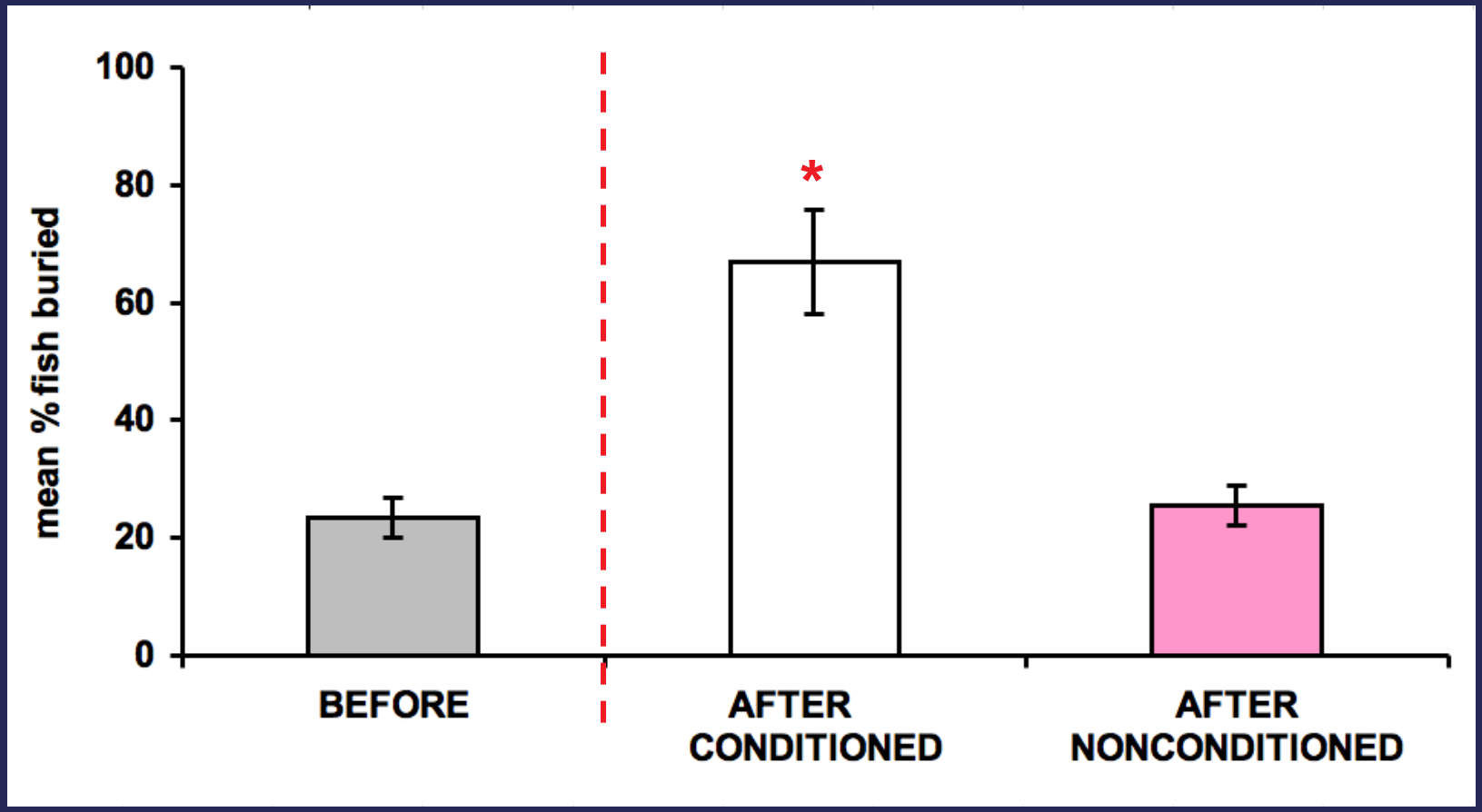
- no pronounced differences evident
- examine daily otolith increments

Burying abilities (2009)



- 20 flounder/trial
- 4 replicates/treatment
- 5 minutes undisturbed
- before & after cage conditioning

Burying abilities (2009)



- before conditioning
- conditioned
- nonconditioned

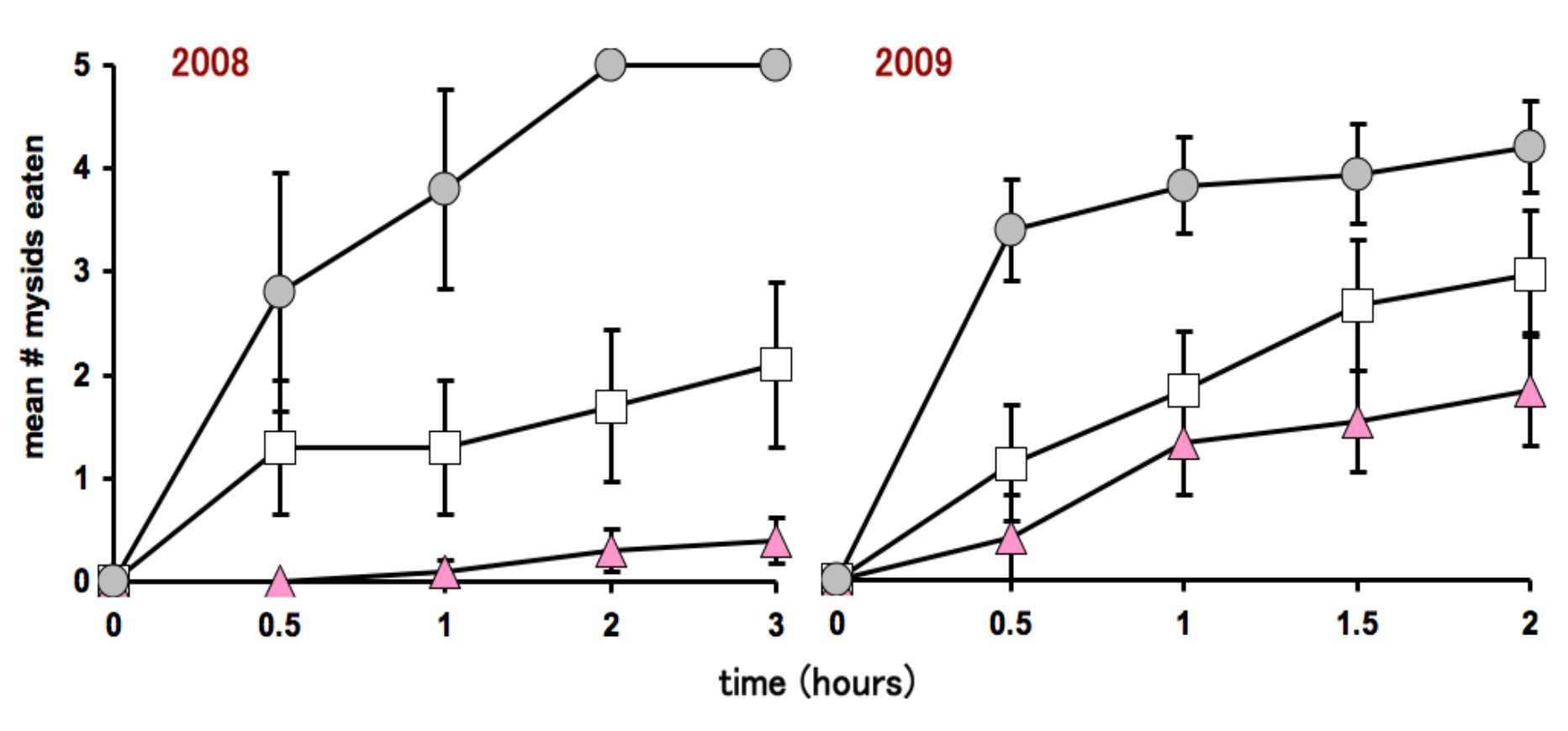
Kruskal-Wallis
(nonparametric ANOVA)
*p < 0.05

Feeding abilities (2008, 2009, 2010)

- 1 flounder/bucket
- 10 replicates/treatment
- 5 natural live prey/bucket
  - mysids (2008, 2009)

Archeomysis sp.

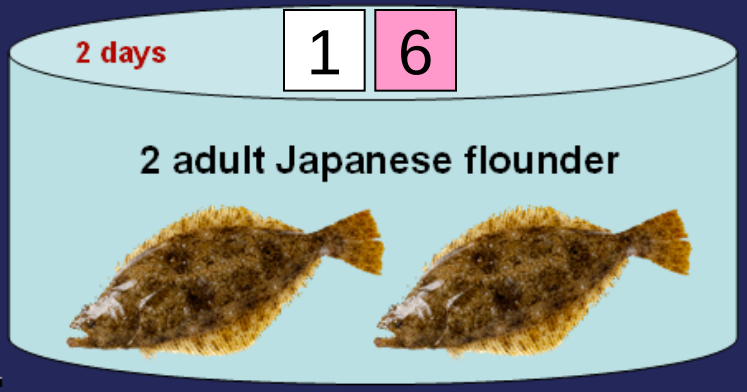
Feeding abilities (2008 & 2009)



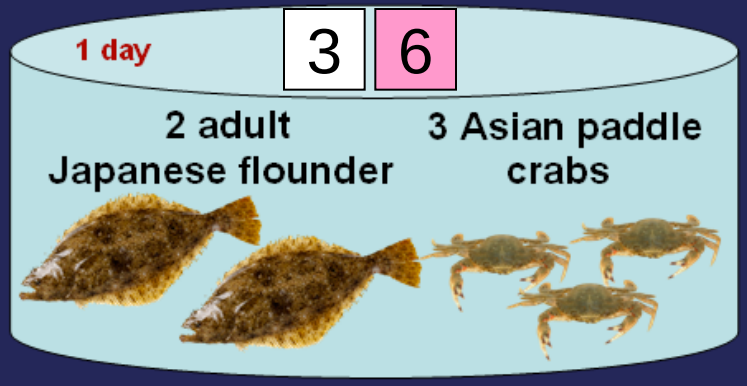
- conditioned
- nonconditioned
- wild

Predator avoidance (2010)

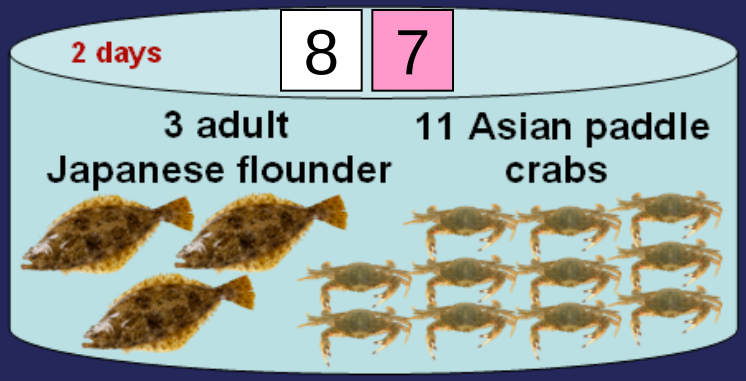
LOW DENSITY



MEDIUM DENSITY



HIGH DENSITY



- 3 treatments
- 30 CONDITIONED + 30 NONCONDITIONED fish/tank
- 6000 l tank

NUMBER EATEN

- conditioned
- nonconditioned

Conclusions

- CONDITIONED > NONCONDITIONED
  - IMMEDIATE BENEFITS: bury, feed, pred. avoid
  - LONG-TERM BENEFITS: movements, recapture rates
- best recapture when fewest fish released
- location location location
- researcher recapture targets “weak” fish?
- large-scale Japanese efforts as case studies

We gratefully acknowledge the help and support of:

JAPAN

Masuda Reiji
Ueno Masahiro
Kai Yoshiaki
Tominaga Osamu
Akiyama Satoshi
Chaitanya Bhandare
Matsui Shoko
Minami Kenji
Ohata Ryosuke
Oshima Masakane
Tokuda Kouji
Watanabe Kenta
The staff of Obama Center
The staff & students at Maizuru Suisan Jikkenjo

US

Elizabeth Fairchild
Hunt Howell
Ben Galuardi
John Hargreaves

Portions of this work will be published in *Reviews in Fisheries Science* in late 2012.

and especially **ALL THE FISHERMEN**

ありがとう
ございます。

"Hirame" Toto-Awase card game, Tango Sea edition, designed by Toto Koubou, Tango Uocchikan Aquarium, Miyazu City, Kyoto.