USING THE SATELLITE ALTIMETRY DATA TO REVEAL PERSPECTIVE AREAS OF THE JAPANESE FLYING SQUID FISHERY IN THE JAPAN SEA

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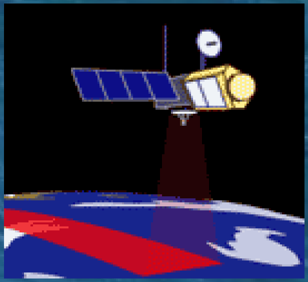
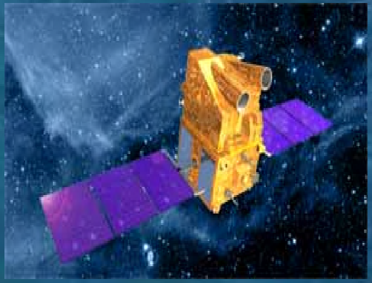




The sea surface height (SSH) is an integral parameter of thermodynamic and dynamic processes. It describes the water conditions better than the sea surface temperature because of the following reasons:

– it reflects thermodynamic conditions of the whole water layer (SST – of the sea surface only);

– it indicates currents, eddies, upwelling/downwelling with better accuracy (SST is indirect tracer);

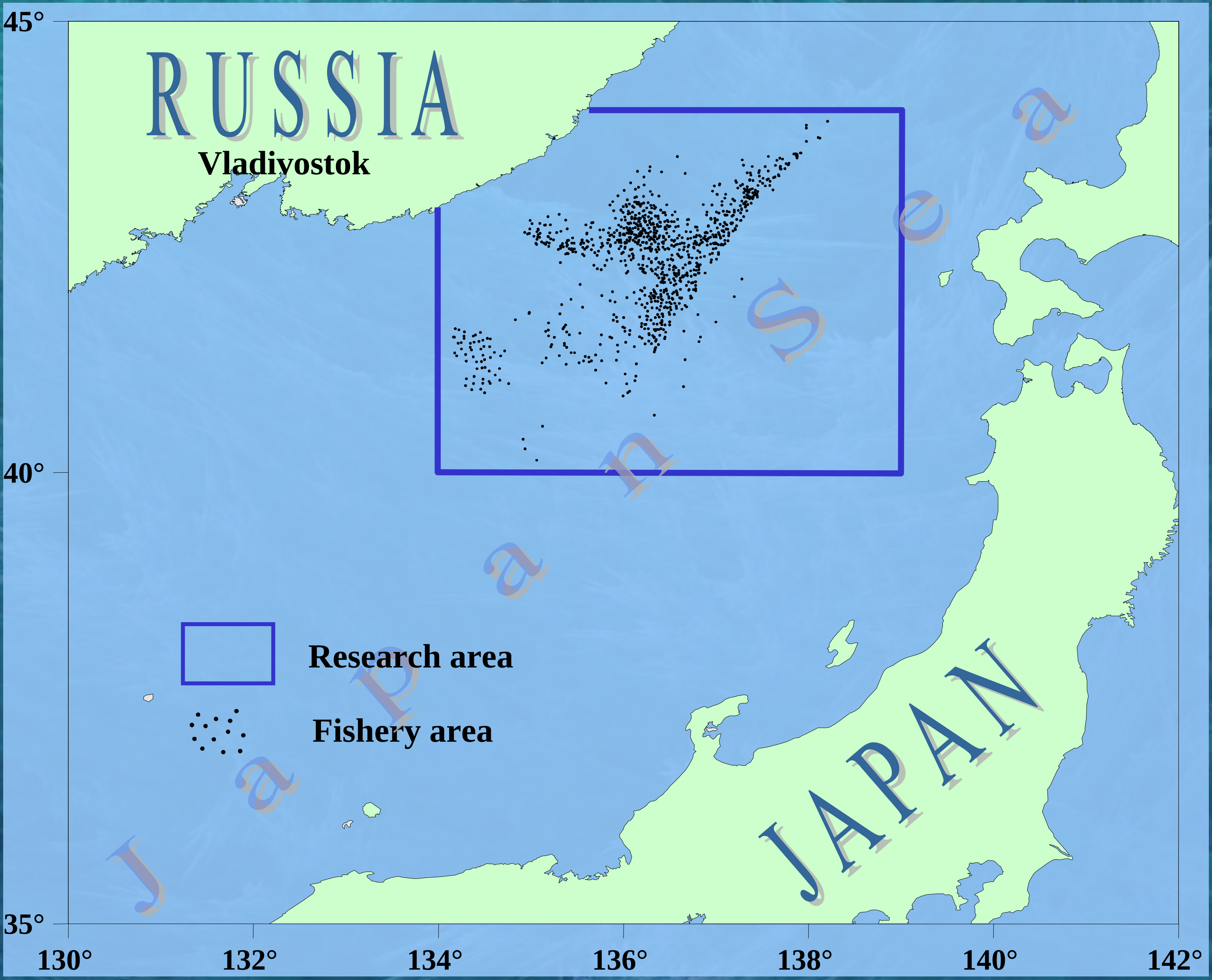
– it is directly connected with dynamics of atmosphere (SST – indirectly, through heat balance).

Satellite altimetry data are used to characterize the sea surface height – the charts of the SSH anomaly produced by Colorado Center for Astrodynamics Research (http://argo.colorado.edu/~realtime/). For the charts, the SSH anomaly (ξ) is calculated relatively to the mean sea surface height with using the data received from all accessible satellites. Besides, tendencies of the SSH change ($\Delta\xi$) are calculated:

$$\Delta\xi = \xi_0 - \xi_7,$$

where ξ_0 - the SSH anomaly at the day of a catch;
ξ_7 - the SSH anomaly in 7 days before the catch.

Research area



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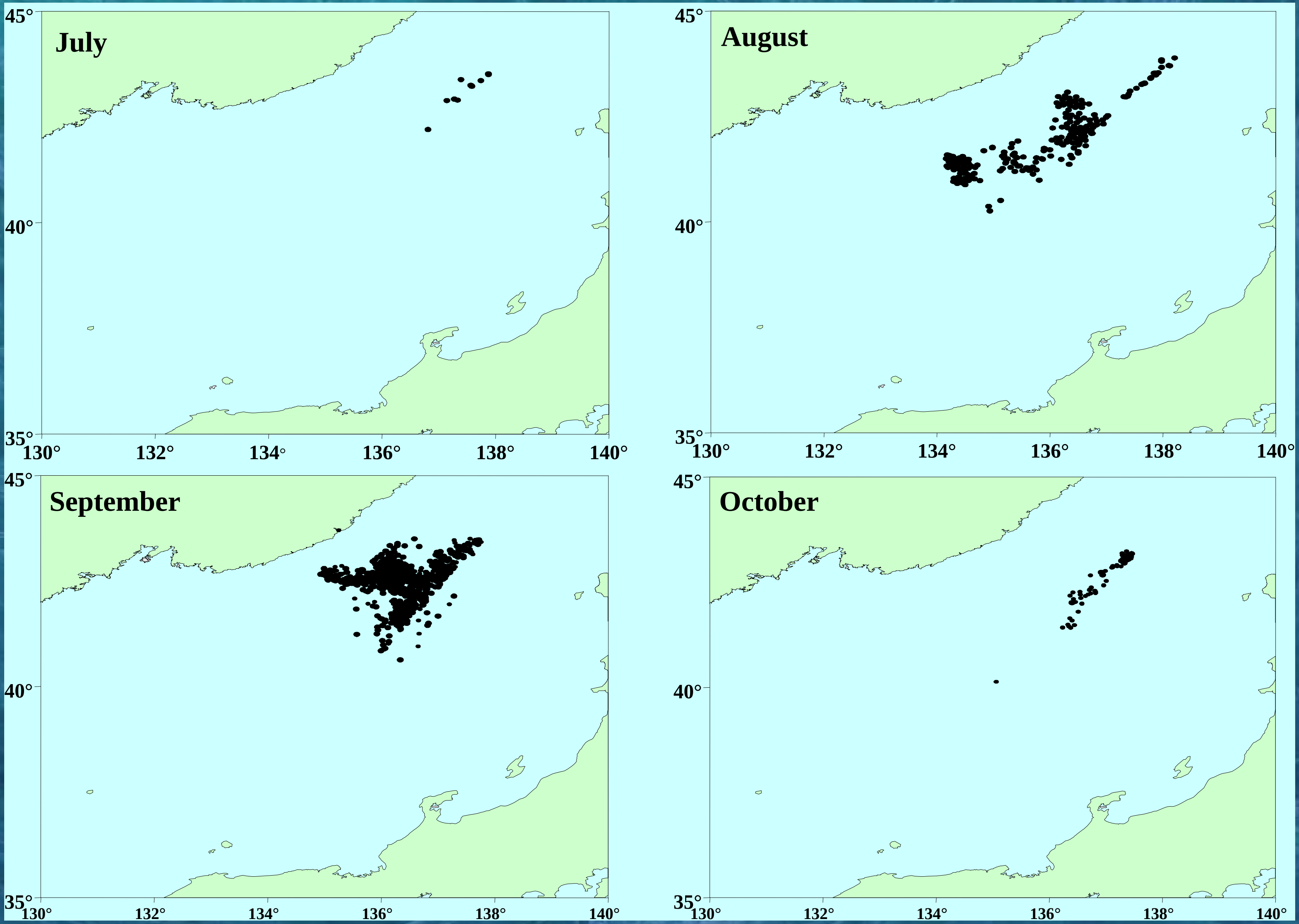
Statistics of the Japanese flying squid fishery in Russian EEZ in 2003

Month	July	August	September	October	Total
Number of catches	10	236	721	71	1038

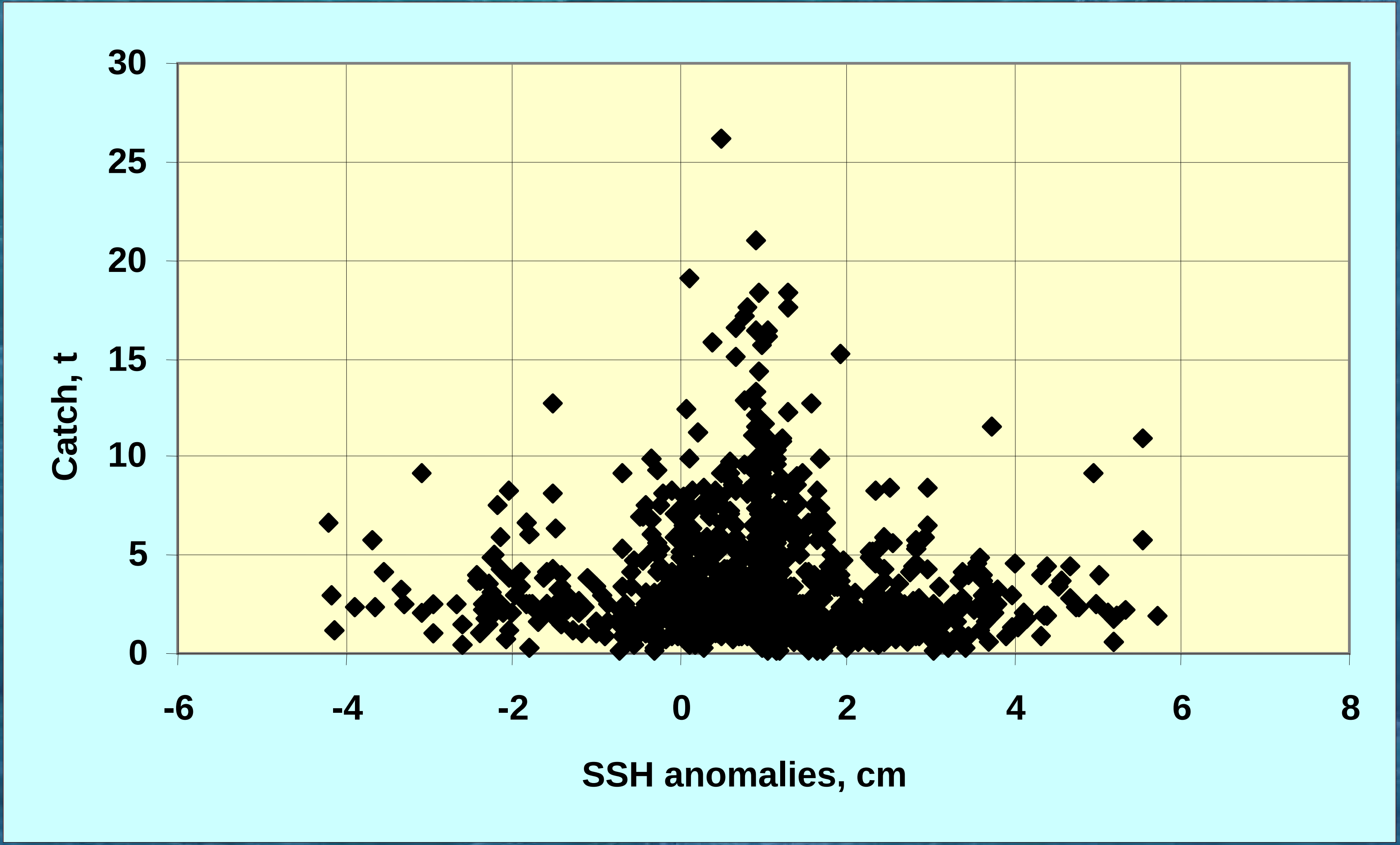
Spatial distribution of the squid fishery by months



The catch success is estimated qualitatively using the following gradation:

- **Low:** daily catch < 0.5 t;
- **Satisfactory:** $0.5 \text{ t} \leq$ daily catch < 1.5 t;
- **High:** $1.5 \text{ t} \leq$ daily catch < 5 t;
- **Very high:** daily catch ≥ 5 t.

Japanese flying squid fishing grounds distribution dependence on SSH anomalies for the whole period of fishery

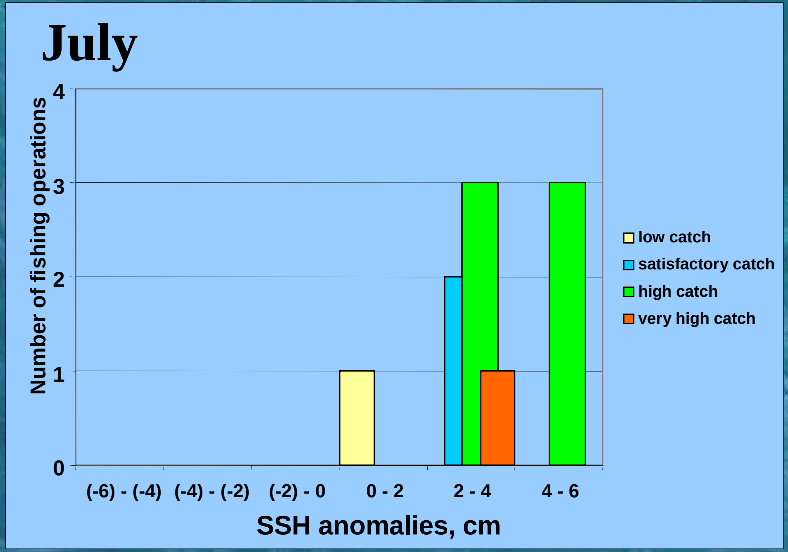


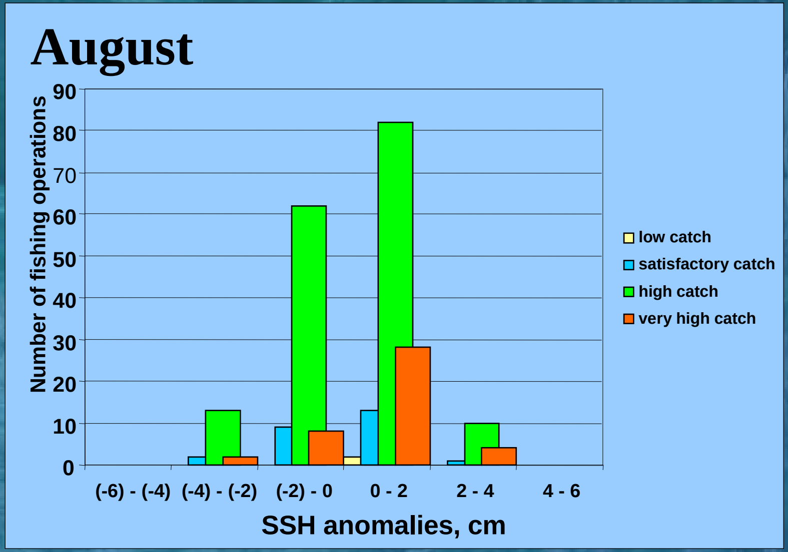
Dependence of Japanese flying squid catches on the SSH anomalies

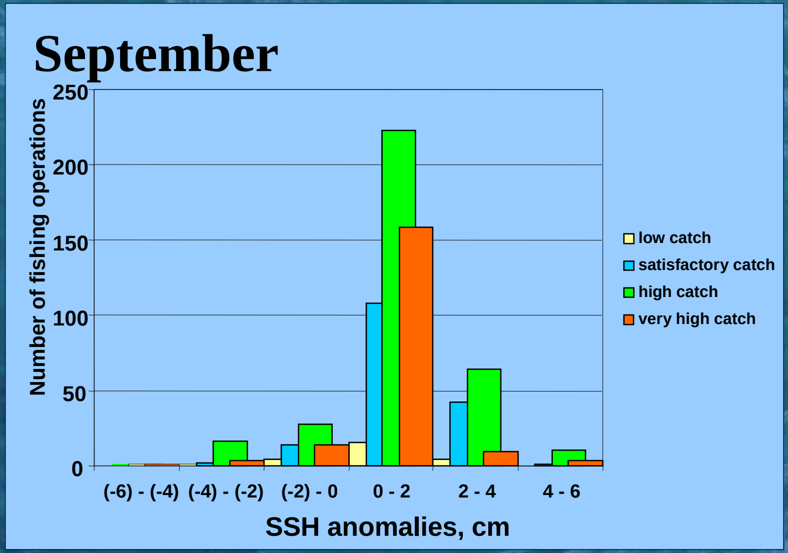
SSH anomalies	Catches, number of cases					Total catch, t				
	Low	Satisfactory	High	Very high	Σ	Low	Satisfactory	High	Very high	Σ
(-6) - (-4)	0	1	1	1	3	0	1.23	3.00	6.64	10.87
(-4) - (-2)	1	4	29	5	39	0.44	4.01	83.42	36.64	124.51
(-2) - 0	5	25	96	23	149	1.31	26.63	263.16	166.45	457.55
0 - 2	18	125	319	189	651	5.46	131.56	960.04	1618.79	2715.85
2 - 4	4	54	97	13	168	1.21	54.20	250.02	92.76	389.19
4 - 6	0	3	21	4	28	0.00	2.94	55.53	25.86	84.33
Σ	28	212	563	235	1038	8.42	220.57	1615.17	1947.14	3791.30

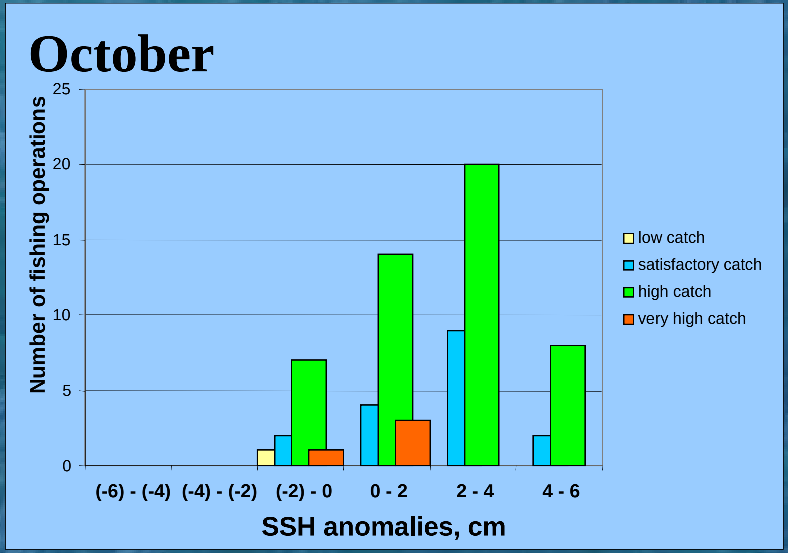
SSH anomalies	Catches number of cases, %					Total catch, %				
	Low	Satisfactory	High	Very high	Σ	Low	Satisfactory	High	Very high	Σ
(-6) - (-4)	0	0.1	0.1	0.1	0.2	0.0	0.0	0.1	0.2	0.3
(-4) - (-2)	0.1	0.4	2.8	0.5	3.8	0.0	0.1	2.2	1.0	3.3
(-2) - 0	0.5	2.4	9.2	2.2	14.4	0.0	0.7	6.9	4.4	12.1
0 - 2	1.7	12.0	30.7	18.2	62.7	0.1	3.5	25.3	42.7	71.6
2 - 4	0.4	5.2	9.3	1.3	16.2	0.0	1.4	6.6	2.4	10.5
4 - 6	0.0	0.3	2.0	0.4	2.7	0.0	0.1	1.5	0.7	2.2
Σ	2.7	20.4	54.2	22.6	100	0.2	5.8	42.6	51.4	100

Japanese flying squid catches dependence on SSH anomalies by months.





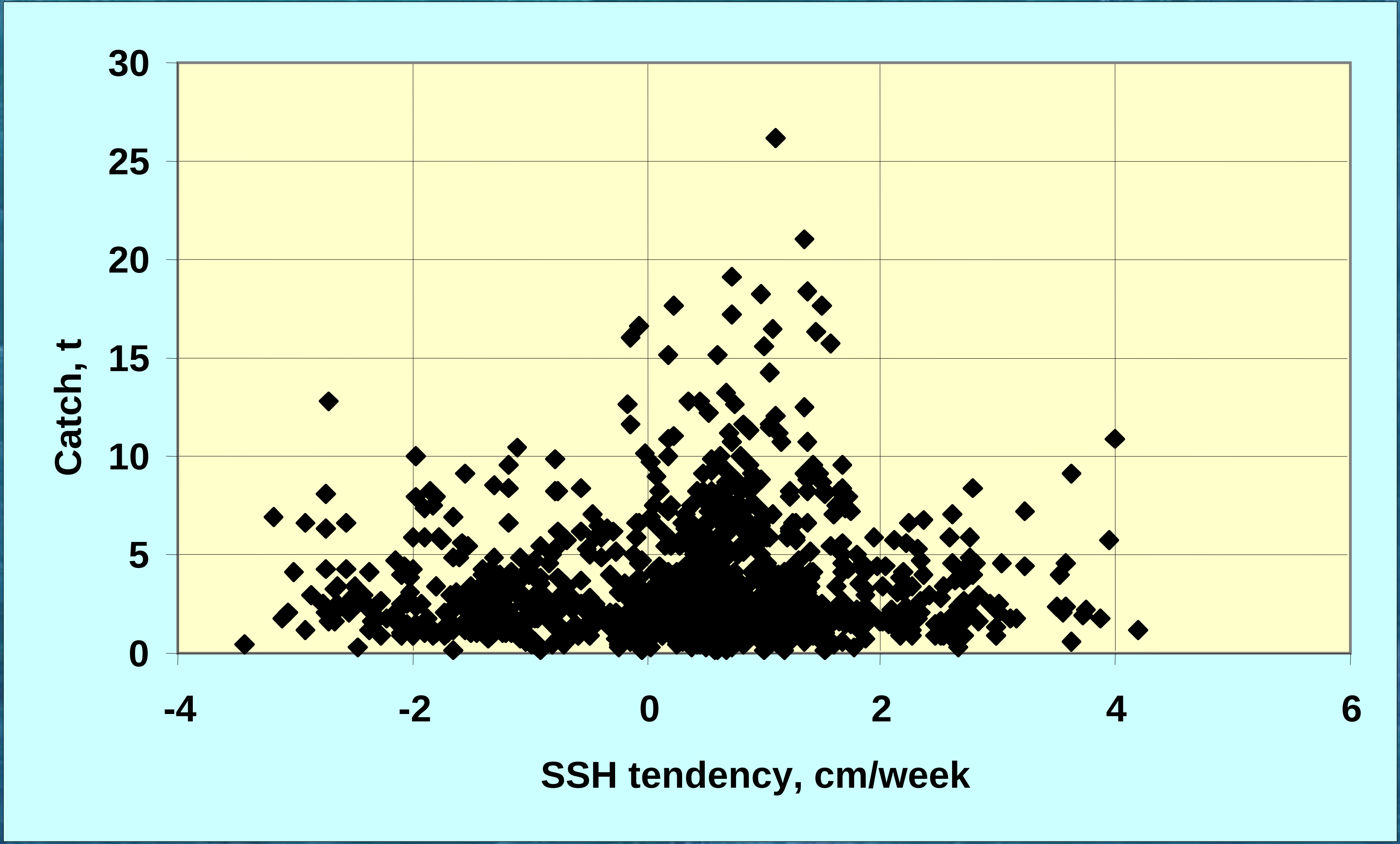




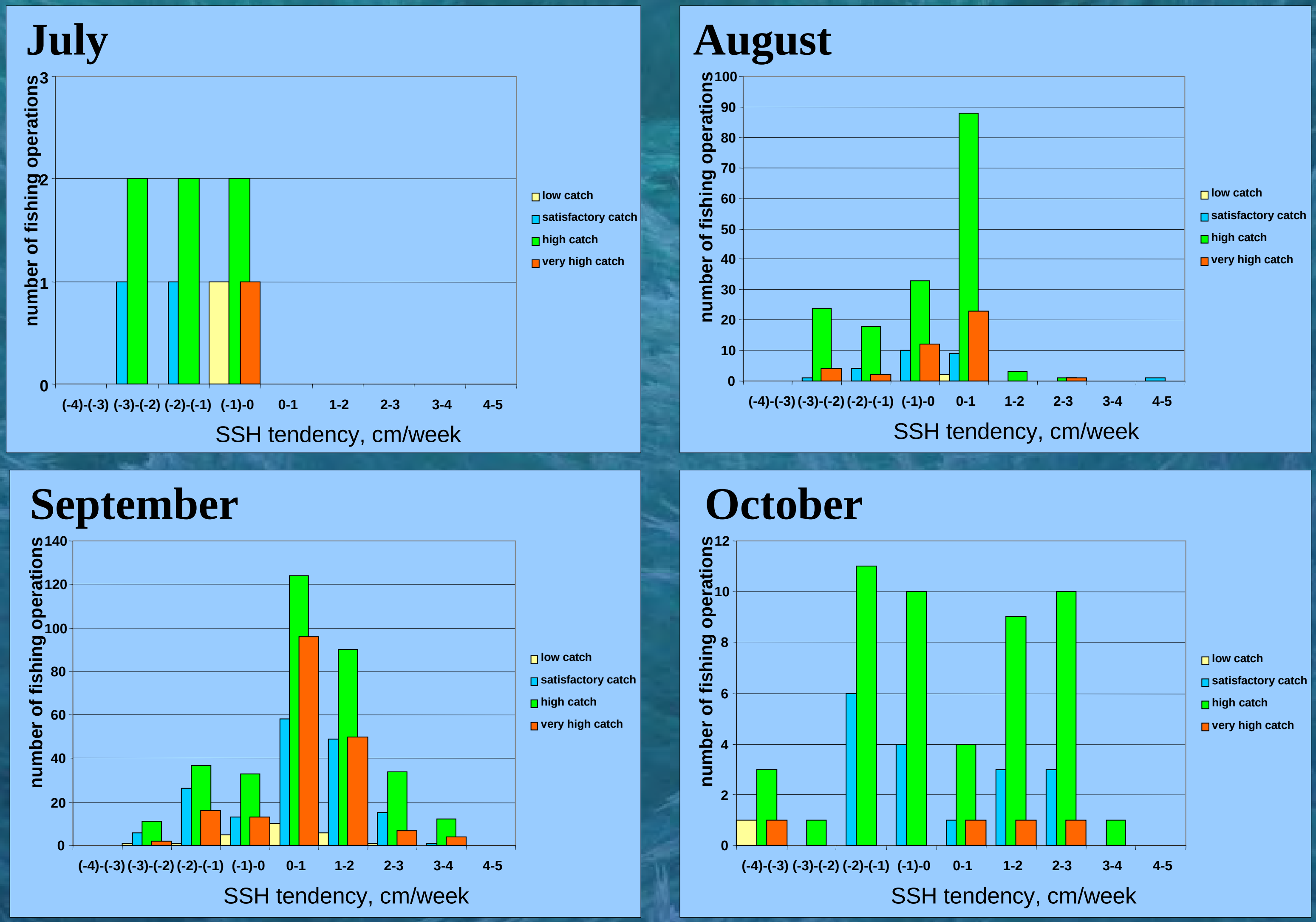
SSH anomaly ranges favorable for the Japanese flying squid fishery

Month	SSH anomaly (cm)
July	+2 - +4
August	-2 - +2
September	0 - +2
October	0 - +4
Whole period	-2 - +4

Japanese flying squid fishing grounds distribution dependence on SSH tendencies for the whole period of fishery.



Japanese flying squid catches dependence on SSH tendencies by months.

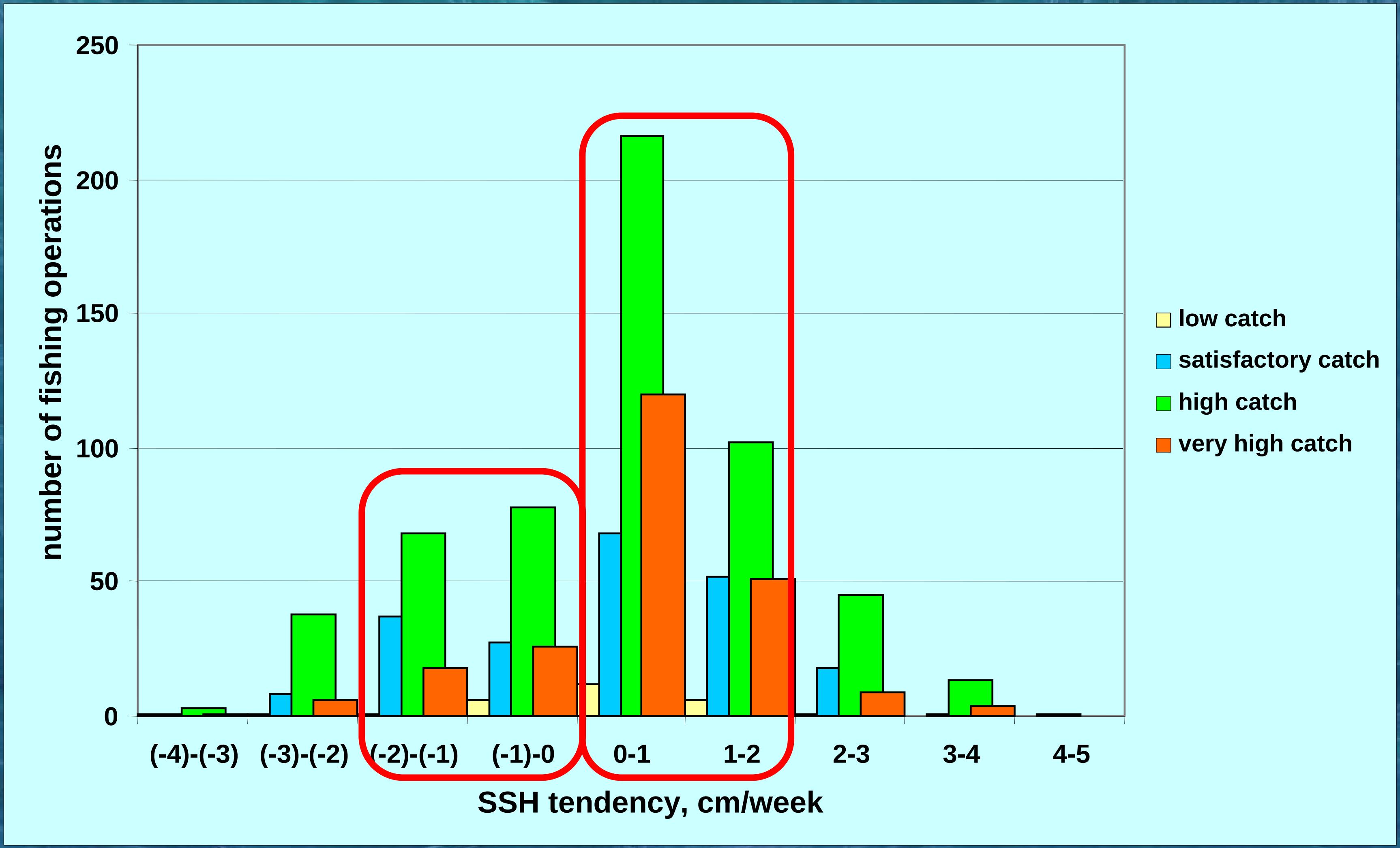


Dependence of Japanese flying squid catches on the SSH tendency

SSH tendency	Catches, number of cases					Total catch, t				
	Low	Satisfactory	High	Very high	Σ	Low	Satisfactory	High	Very high	Σ
(-4) - (-3)	1	0	3	1	5	0.43	0.00	7.96	6.87	15.26
(-3) - (-2)	1	8	38	6	53	0.25	8.75	105.23	46.34	160.57
(-2) - (-1)	1	37	68	18	124	0.16	42.21	196.91	136.91	376.19
(-1) - 0	6	27	78	26	137	1.93	26.07	215.27	203.17	446.44
0 - 1	12	68	216	120	416	3.72	69.75	633.51	976.11	1683.09
1 - 2	6	52	102	51	211	1.68	52.52	288.80	487.83	57.11
2 - 3	1	18	45	9	73	0.25	19.36	131.54	57.11	208.26
3 - 4	0	1	13	4	18	0.00	0.66	35.96	33.00	69.62
4 - 5	0	1	0	0	1	0.00	1.25	0.00	0.00	1.25
Σ	28	212	563	235	1038	8.4	220.6	1615.2	1947.3	3791.5

SSH tendency	Catches number of cases, %					Total catch, %				
	Low	Satisfactory	High	Very high	Σ	Low	Satisfactory	High	Very high	Σ
(-4) - (-3)	0.1	0.0	0.3	0.1	0.5	0.0	0.0	0.2	0.2	0.4
(-3) - (-2)	0.1	0.8	3.7	0.6	5.1	0.0	0.2	2.8	1.2	4.2
(-2) - (-1)	0.1	3.6	6.6	1.7	11.9	0.0	1.1	5.2	3.6	9.9
(-1) - 0	0.6	2.6	7.5	2.5	13.2	0.1	0.7	5.7	5.4	11.9
0 - 1	1.2	6.6	20.8	11.6	40.1	0.1	1.8	16.7	25.7	44.4
1 - 2	0.6	5.0	9.8	4.9	20.3	0.0	1.4	7.6	12.9	21.9
2 - 3	0.1	1.7	4.3	0.9	7.0	0.0	0.5	3.5	1.5	5.5
3 - 4	0.0	0.1	1.3	0.4	1.7	0.0	0.0	0.9	0.9	1.8
4 - 5	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Σ	2.7	20.4	54.2	22.6	100	0.2	5.8	42.6	51.4	100.0

Japanese flying squid catches dependence on SSH tendencies for the whole period of fishery



The catch value distribution in 2-dimensional space (ξ and $\Delta\xi$) is considered. The quarters of $\xi/\Delta\xi$ - diagram are interpreted as follows:

1st quarter:

$\xi > 0$ and $\Delta\xi > 0$ – strengthening convergence;

2nd quarter:

$\xi > 0$ and $\Delta\xi < 0$ – weakening convergence;

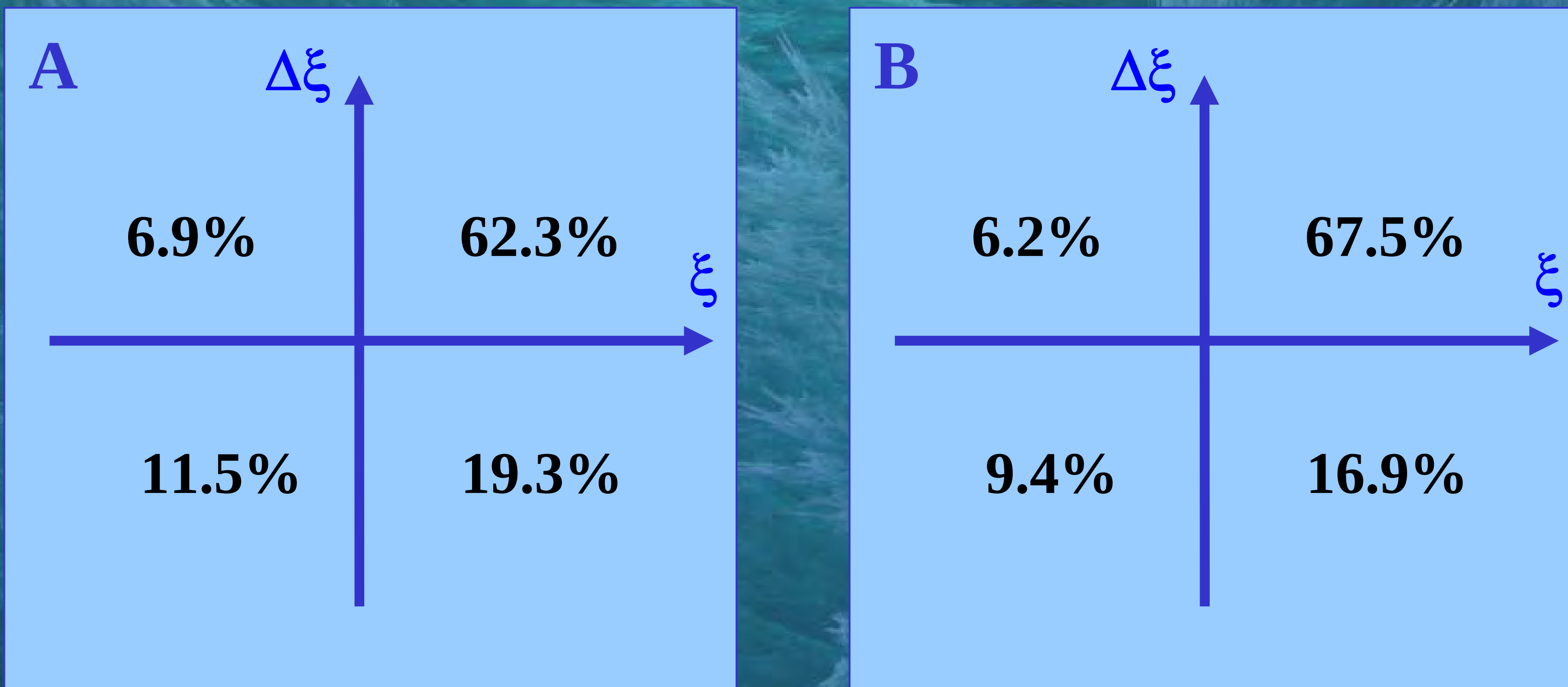
3rd quarter:

$\xi < 0$ and $\Delta\xi < 0$ – strengthening divergence;

4th quarter:

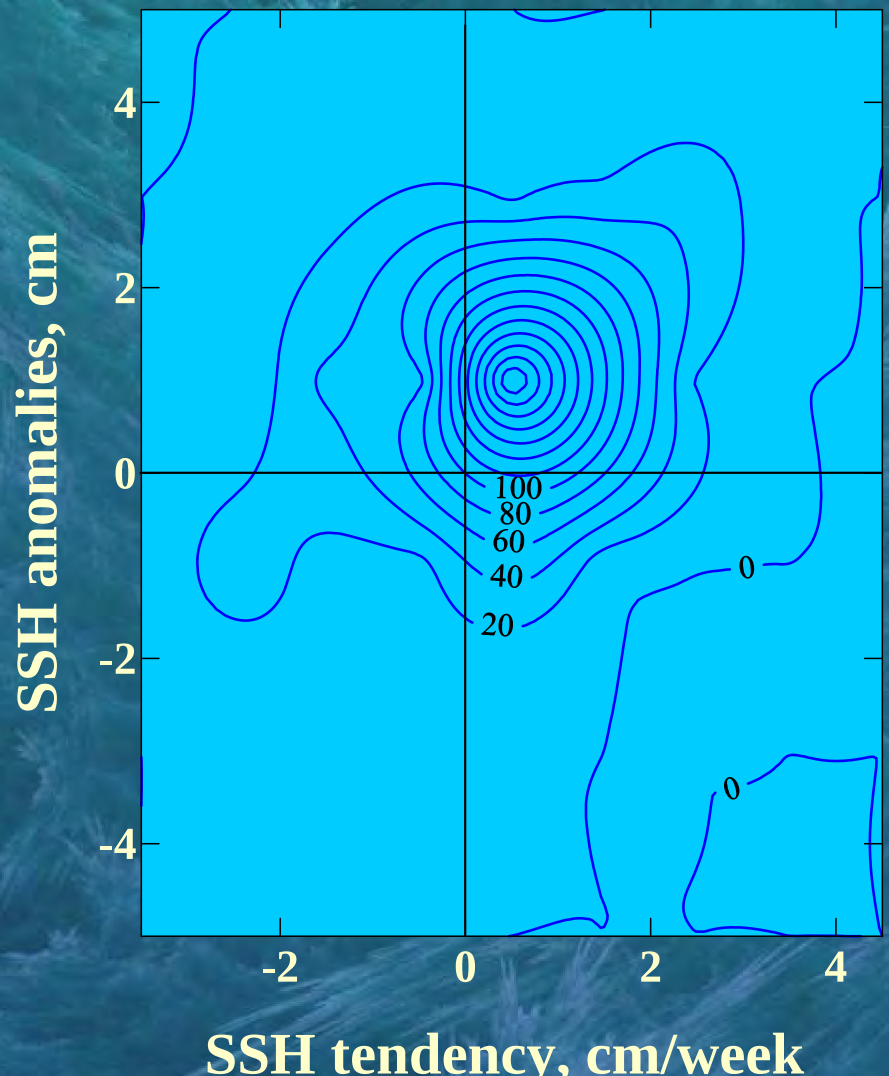
$\xi < 0$ and $\Delta\xi > 0$ – weakening divergence.

Japanese flying squid fishery parameters dependence on SSH anomalies and SSH tendencies, by quarters in ξ / Δξ coordinates.



A - number of fishing operations, B - total catch

Number of high and very high catches of Japanese flying squid in dependence on SSH anomalies and SSH tendencies



Thank you
for your attention!