Using the satellite altimetry data to reveal perspective areas of the neon flying squid fishery

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Abstract - Relation between distribution of fishery for the neon flying squid and water dynamics in the south Kuril area was analyzed basing on driftnet squid catches during the summer-autumn periods in 1998-2001. and on the ocean level as revealed from satellite altimetry. As a result. we have found that all squid catches were observed within the anomaly range from -25 to 15 cm. and most of positive sets (over 83%) were made within the range from -10 to 5 cm. Squid schooled in commercial concentrations within dynamically stable regions between cyclonic and anticyclonic areas with a slight shift towards cyclonic zones.

Keywords: satellite altimetry. sea level anomaly. driftnet squid catches. south Kuril area

1. INTRODUCTION

Oceanographic maintenance of fishery is traditionally based on the ship and remote sensing information on water temperature. Recently. progress of the satellite altimetry has led to revolutionary changes in studies of the ocean variability in a wide range of space-time scales. which were not covered with regular observations earlier. Joint using of altimetric and temperature information is very important and perspective for analysis and forecast of oceanographic conditions favorable for fishing grounds formation. the ways and dates of feeding and spawning migrations (Foux, Zdorovennova, 2001; Staritsyn et al.. 2004).

Data on the ocean level could be used as integral indices of intensity of thermodynamic and dynamic processes that reflect abiotic conditions of commercial species habitat. The sea level describes the abiotic conditions better than sea surface temperature due to the following reasons:

- it reflects thermodynamic state of the whole water layer. not only that of the sea surface;
- it indicates currents. eddies. upwelling and downwelling areas with better accuracy;
- it is directly connected with variability of atmospheric processes.

We made an attempt to analyze distribution of the neon flying squid in the south Kuril region in dependence on the satellite altimetry data. The goal was investigation the opportunity to use the satellite altimetry data for determination of favorable conditions for the squid concentration.

2. DATA AND ANALYSIS METHOD

The data on driftnet squid catches in the summer-autumn periods of 1998-2002 were used for the analysis (Tab. 1). Monofilament driftnets with mesh size 90-120 mm and width 8-9 m were used to catch the squid. All fishing operations were made at nighttime. One hundred nets (tans) per one fishing array were deployed. Each vessel deployed 1-4 net arrays. i.e. 100-400 tans. A total of 577 tans were set during the whole period of the research activity. CPUE (catch per unit effort. in kg per 100 m of net per a night) was used as a measure of the fishing success that allowed to compare the results of different vessels which used the nets with variable length.

Table 1. Distribution of the Used Fishery Information. by Years

Year	Number of fishing operations
1998	414
1999	56
2001	42
2002	65

As the satellite altimetry data. we used the sea level anomaly charts produced by Colorado Center for Astrodynamics Research (USA). The charts are issued each 10 days. The level anomalies were estimated in 5 cm intervals. Besides. magnitude of the sea level tendency ($\Delta\xi$. cm/10 days) in 10 days previous to fishing operations were calculated:

$$\Delta\xi = \xi_0 - \xi_{10},$$

where ξ_0 is the anomaly of sea level at the moment of the net deployment;

ξ_{10} is the anomaly of sea level in 10 days before the deployment

Staritsyn et al. (2004) showed. that $\Delta\xi < 0$ means a divergence of a complete flow. while $\Delta\xi > 0$ means its convergence. The areas of the divergence are corresponded with frontal zones and intensive upwelling. which cause heightened biological and fisheries productivity. as a rule. The convergence of currents causes concentration of plankton and planktonivorous nekton.

The catch data for a particular night were laid upon the charts of the sea level anomalies and tendencies.

3. RESULT AND DISCUSSION

At the first phase of investigation. the dependence of the neon flying squid fishing grounds on the sea level anomalies was considered (Fig. 1). The squids were caught in the areas with the sea level anomalies between (-25) and (+15) cm. However. the major part of the fishing operations (more than 84 %) were made in the narrow range of the anomalies from (-10) to (+5) cm. where 83 % of the total catch was obtained (Tab. 2). Note. that the maximal anomalies of the sea level in the investigated area reached 80-100 cm. So. we conclude that fishing grounds of the squid formed in dynamically stable zones between cyclonic and anticyclonic zones. with slight shift towards cyclonic formations.

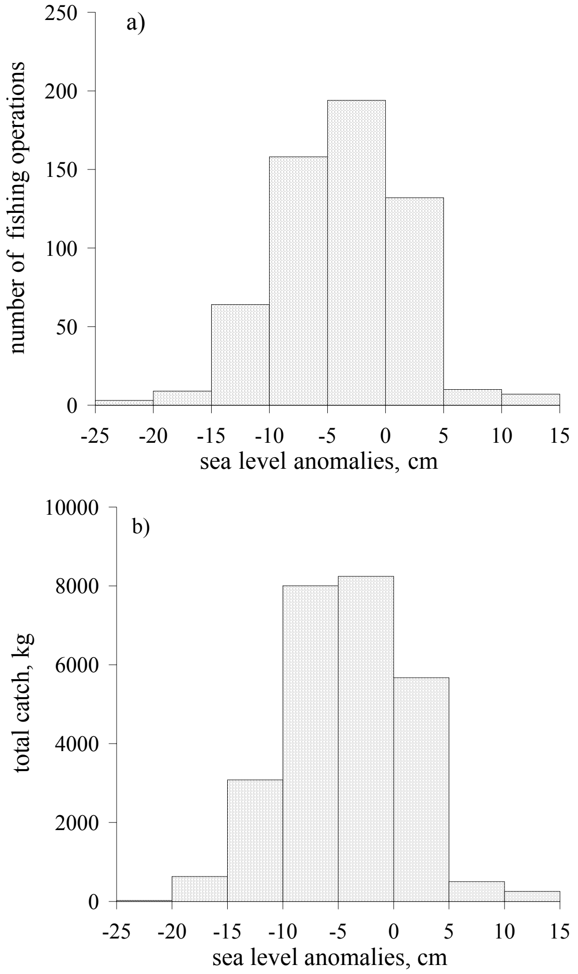

Figure 1. Dependence of effective fishing operations (a) and total neon flying catches (b) on the sea level anomalies in 1998-2002

Table 2. Dependence of effective fishing operations and total neon flying squid catches on the sea level anomalies.

Sea level anomalies	Number of fishing operations		Total catch	
	Number	%	Kg	%
(-25) - (-20)	3	0.5	25.3	0.1
(-20) - (-15)	9	1.6	632.5	2.4
(-15) - (-10)	64	11.1	3080.6	11.7
(-10) - (-5)	158	27.4	8002.3	30.3
(-5) - 0	194	33.6	8243.6	31.2
0 - 5	132	22.9	5672.8	21.5
5 - 10	10	1.7	499.5	1.9
10 - 15	7	1.2	254.1	1.0
	577	100	26410.8	100

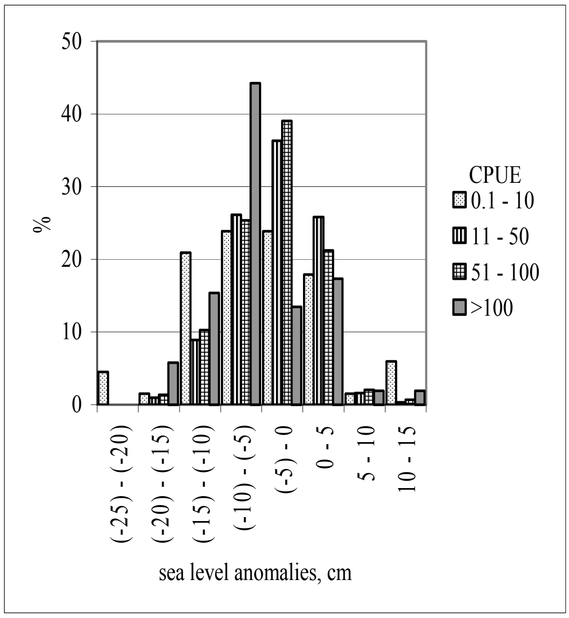

Figure 2. Dependence of fishing squid catches on the sea level anomalies in 1998-2002.

Table 3. Dependence of neon flying squid catches on the sea level anomalies.

Sea level anomalies	Catches number of cases				Catches. %			
	Low	Satisfactory	High	Very high	Low	Satisfactory	High	Very high
(-25) - (-20)	3	0	0	0	4.5	0.0	0.0	0.0
(-20) - (-15)	1	3	2	3	1.5	1.0	1.4	5.8
(-15) - (-10)	14	28	15	8	20.9	8.9	10.3	15.4
(-10) - (-5)	16	82	37	23	23.9	26.1	25.3	44.2
(-5) - 0	16	114	57	7	23.9	36.3	39.0	13.5
0 - 5	12	81	31	9	17.9	25.8	21.2	17.3
5 - 10	1	5	3	1	1.5	1.6	2.1	1.9
10 - 15	4	1	1	1	6.0	0.3	0.7	1.9

Further we considered. whether was any connection between distinctions in the sea level and the catch values. For this purpose. all catches (C) were divided into four groups:

- Low catch: $0.1 \leq C < 10$ kg/100 m night;
- Satisfactory catch: $10 \leq C < 50$ kg/100 m night;
- High catch: $50 \leq C < 100$ kg/100 m night;
- Very high catch: $C \geq 100$ kg/100 m night.

Let's note. that squid catches from all these groups occurred at least once in all intervals of the sea level anomalies in which the fishery was conducted (Fig. 2).

The most important is distribution of high and very high catches of the squid. In total. 146 high and 52 very high catches were observed (Tab. 3). The high catches located mainly (85.8 %) in the areas of weak negative zero or weak positive anomalies of the sea level within the range from (-10) to (+5) cm. and 39.0 % of them were obtained in the narrow interval of the anomalies between (-5) and (0) cm. Majority of the very high catches (90.4 %) were observed in the areas with the anomalies of sea level from (-15) to (+5) cm. with pronounced maximum (44.2 %) in the interval between (-10) and (-5) cm (Fig. 2). Satisfactory catches distributed similar with high ones (Tab. 3). So. we conclude that probability of successful fishing operations with satisfactory or better results is essentially higher in the areas with weak negative or zero anomalies of the sea level laying in the intervals from (-10) to (0) cm.

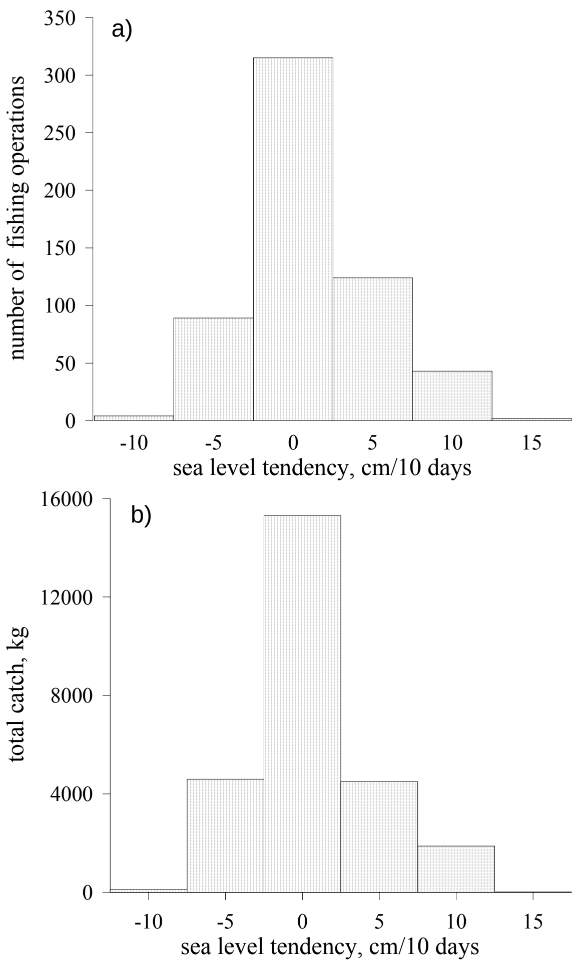

Figure 3. Dependence of effective fishing operations number (a) and total neon flying catches (b) on the sea level tendency in 1998-2002

Table 4. Dependence of effective fishing operations number and total neon flying squid catches on the tendency sea level change.

Tendency of the sea level change	Number of fishing operations		Total catch	
	Number	%	Kg.	%
-10.00	4	0.7	114.1	0.4
-5.00	89	15.4	4601.7	17.4
0.00	315	54.6	15306.7	58.0
5.00	124	21.5	4489.7	17.0
10.00	43	7.5	1883	7.1
15.00	2	0.3	15.5	0.1
	577	100	26410.7	100

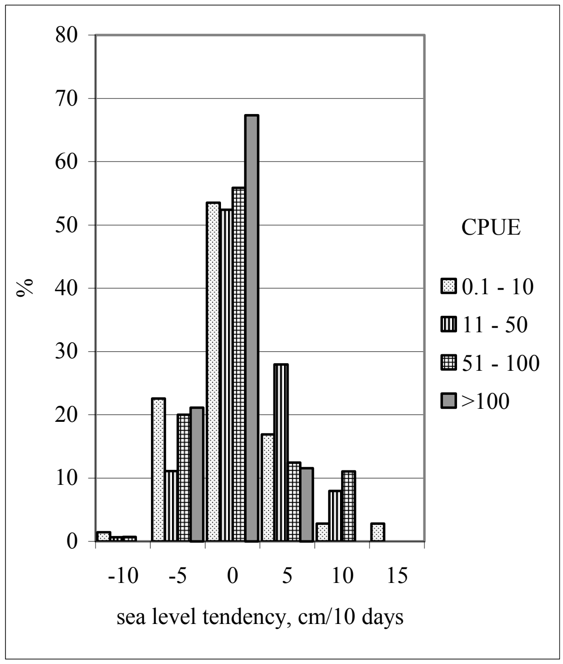

Figure 4. Dependence of flying squid catches on the sea level tendency in 1998-2002.

Table 5. Dependence of effective fishing operations number and total neon flying squid catches on the tendency sea level change.

Tendency of the sea level change	Catches. number of cases				Catches. %			
	Low	Satisfactory	High	Very high	Low	Satisfactory	High	Very high
-10	1	2	1	0	1.4	0.6	0.7	0.0
-5	16	35	29	11	22.5	11.1	20.0	21.2
0	38	165	81	35	53.5	52.4	55.9	67.3
5	12	88	18	6	16.9	27.9	12.4	11.5
10	2	25	16	0	2.8	7.9	11.0	0.0
15	2	0	0	0	2.8	0.0	0.0	0.0

Then distribution of the successful catches of neon flying squid was considered in dependence on the tendency of sea level change ($\Delta\xi$) in 10 days before the nets deployment (Tab. 4. Fig. 3). As it has been mentioned earlier. $\Delta\xi < 0$ is the condition of a complete flow divergence and $\Delta\xi > 0$ means a convergence of complete flow. The whole area of fishing operations spread over wide range of the ocean level tendency values from (-10) to (+15) cm. but pronounced maximum of their distribution (54.7 %) was observed in the areas with quasi-stationary sea level ($\Delta\xi \approx 0$). where 58 % of the total catch was obtained. The same value (0) corresponded to the maximal probability of all groups of the catches (Tab. 5). All very high catches were observed in narrow range of the sea level tendencies from (-5) to (+5) cm per 10 days (Fig. 4).

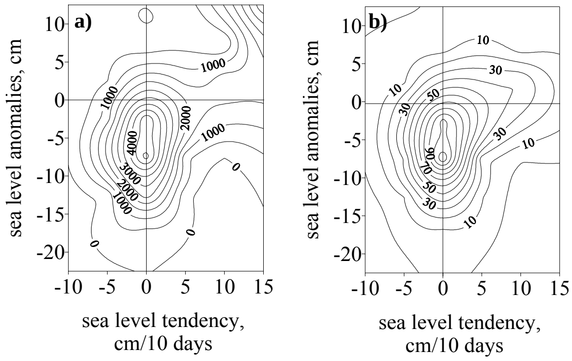

Figure 5. Dependence of the total neon flying squid catches (a) and the number of effective fishing operations (b) on the values of the sea level anomalies and the sea level tendency in 1998-2002.

Thus, a certain dependence of commercial concentrations of neon flying squid on topography of the ocean surface is revealed, which could be illustrated by Figure 6. Both number of fishing operations and the catch values depend on the value of sea level anomalies (ξ, cm) and on the tendency of its change ($\Delta\xi$, cm/10 days). The maximums were observed in the areas with weak negative anomalies of sea level (on slopes of cyclones), in conditions of the level stability ($\Delta\xi \approx 0$).

4. REFERENCES

Foux V.R., Zdorovennova G.E. "The level of northwest Pacific as predictor of abiotic conditions", Bull. St.Petersburg State University, ser. 7, issue 1(№7), p.p. 5-17, 2001

Staritsyn D.K., Filatov V.N., Foux V.R. "Bases of satellite altimetry information adaptation to estimate the conditions of saury commercial congestions formation". Izvestiya TINRO, vol.137, p.p. 398-408, 2004.