Probabilistic Approach to the Estimate of Marine Biological Objects by the Data of Area Surveys

ILIYAS SHAFIKOV,

ni povi ch ol ar \esear ch nst i t ut e of ari ne i sher i es and ceanogr aphy (. \),

, ni povi ch t r eet , ur mansk, , \ussi a

hone: (+) - - - - -, ax: (+) - - - - -,

-mai l: l t ei @pi nr o. r u

eb: www. pi nr o. r u

The main methodological approach

Using for interpolation and extrapolation on all survey area not numerical values calculated density data which got on base of measured raw survey data, and probabilities hit of calculated density data in appointed interval classes values which calculate and determine by Monte-Carlo method.

Input data

- ρ_i *(X, Y)*

Positions		Density (objects number/sq. mile)
Latitude	Longitude	
41.1585	67.7659	17
41.158	67.6385	0
41.1577	67.752	0
41.1585	67.7659	17
41.1594	67.7799	34
41.5035	67.91	0
41.5034	67.9259	0
41.5034	67.9418	0
41.5031	67.9595	0
41.5026	67.9756	0
42.1613	66.7377	0
42.1595	66.7698	7
42.1562	66.8292	7
42.1546	66.8589	141
42.153	66.8767	1268
42.1529	66.8916	141

Classes of input data

- $G1_j \le \rho_i(X,Y) \le G2_j$
- 0-class
  ($\rho_i(X,Y)=0$,
  $G1_j=0$, $G2_j=0$).

Number of class	Limits	
	lower	upper
1	0	0
2	1	100
3	101	250
4	251	500
5	501	1000
6	1001	2000
7	2001	3000

Probability of class value

- $P(j) = \frac{n_j}{N}$

Number of class	Limits		n	P
	Lower	Upper		
1	0	0	281	0.418
2	1	100	269	0.402
3	101	250	58	0.086
4	251	500	39	0.058
5	501	1000	21	0.031
6	1001	2000	3	0.004
7	2001	3000	1	0.001

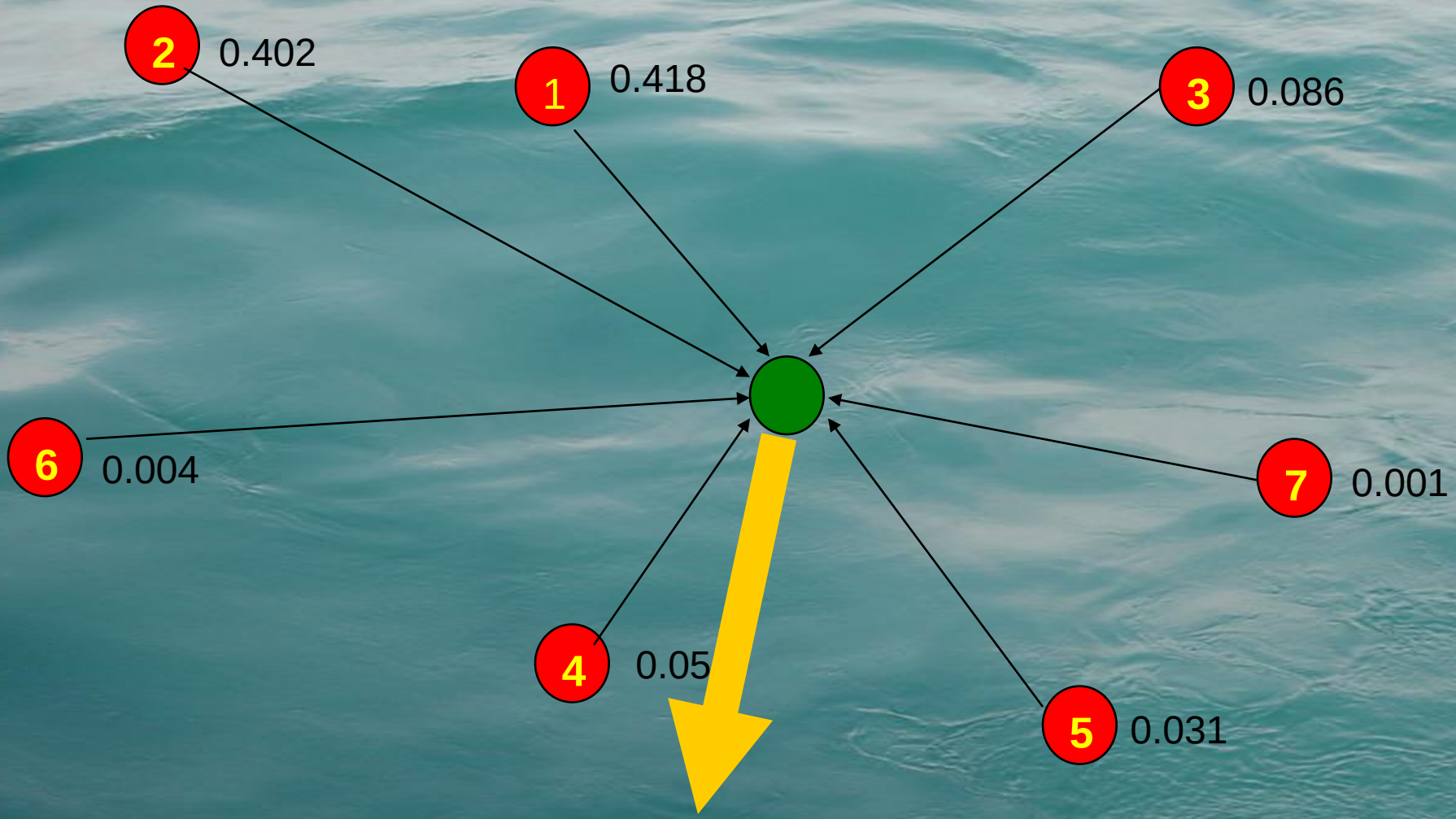
Positions		Density (objects number/sq. mile)	Number of class	P
Latitude	Longitude			
41.159	67.7659	17	2	0.402
41.158	67.6385	0	1	0.418
41.158	67.752	0	1	0.418
41.159	67.7659	17	2	0.402
41.159	67.7799	34	2	0.402
41.504	67.91	0	1	0.418
41.503	67.9259	0	1	0.418
41.503	67.9418	0	1	0.418
41.503	67.9595	0	1	0.418
41.503	67.9756	0	1	0.418
42.161	66.7377	0	1	0.418
42.16	66.7698	7	2	0.402
42.156	66.8292	7	2	0.402
42.155	66.8589	141	2	0.086
42.153	66.8767	1268	6	0.004
42.153	66.8916	141	2	0.086

Moulting patches in 2005 (in example of harp seal in the White Sea)

Values calculation in cells

- $S_k(j) = W^* \sum_{i=1}^{N} P_i(j)$

Evenly-accident	**W=** $\frac{1}{R_{ik}}$
Group	**W=** $\frac{1}{R^2_{ik}}$
Aggregated	**W=** $\frac{1}{R^3_{ik}}$



1	2	3	4	5	6	7
0.008	0.0125	0.0031	0.0254	0.0028	0.0051	0.0002

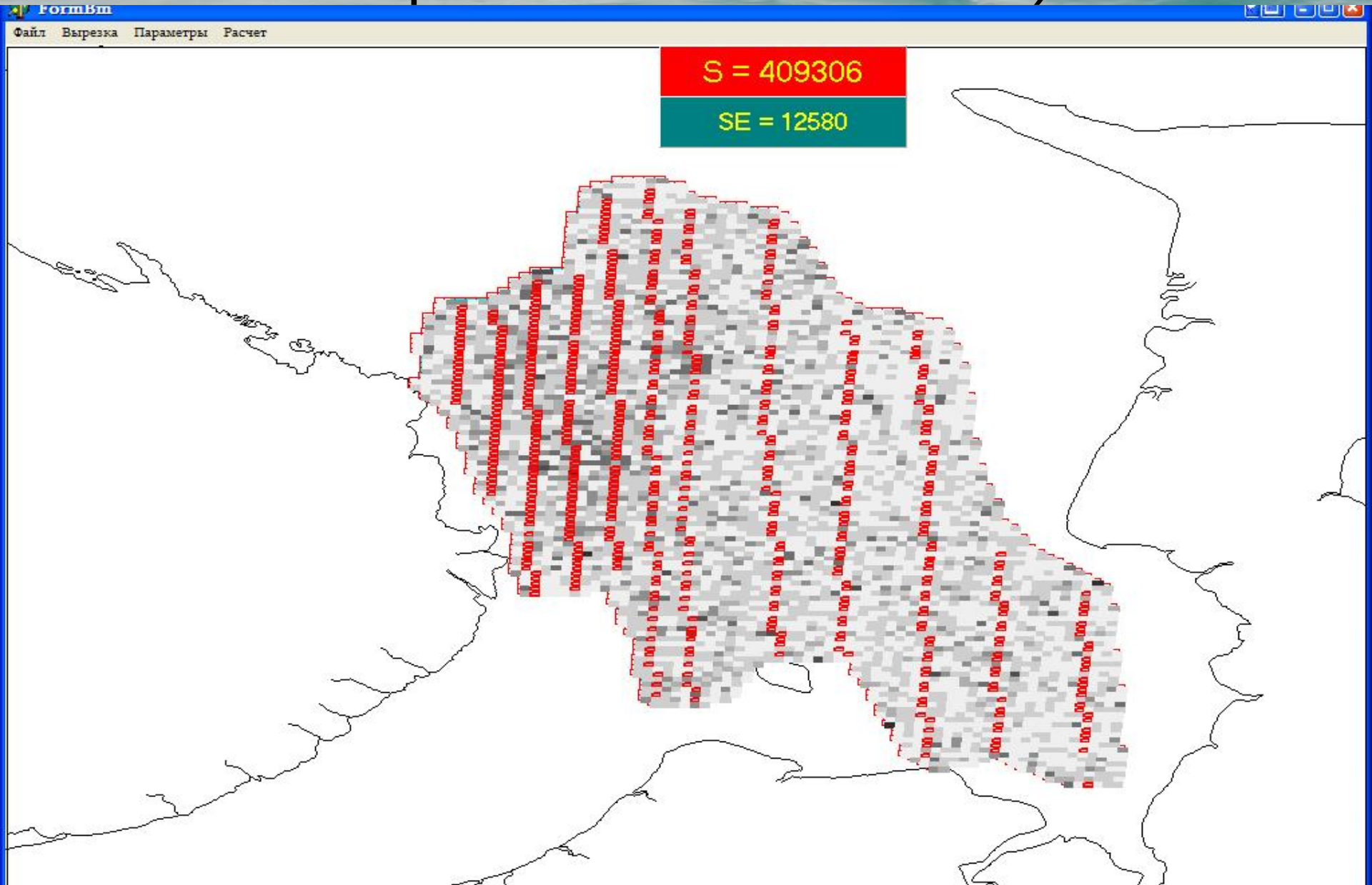
Monte-Carlo method using

$$P(j) = \frac{S(j)}{\sum_{j=1}^{L} S(j)}$$

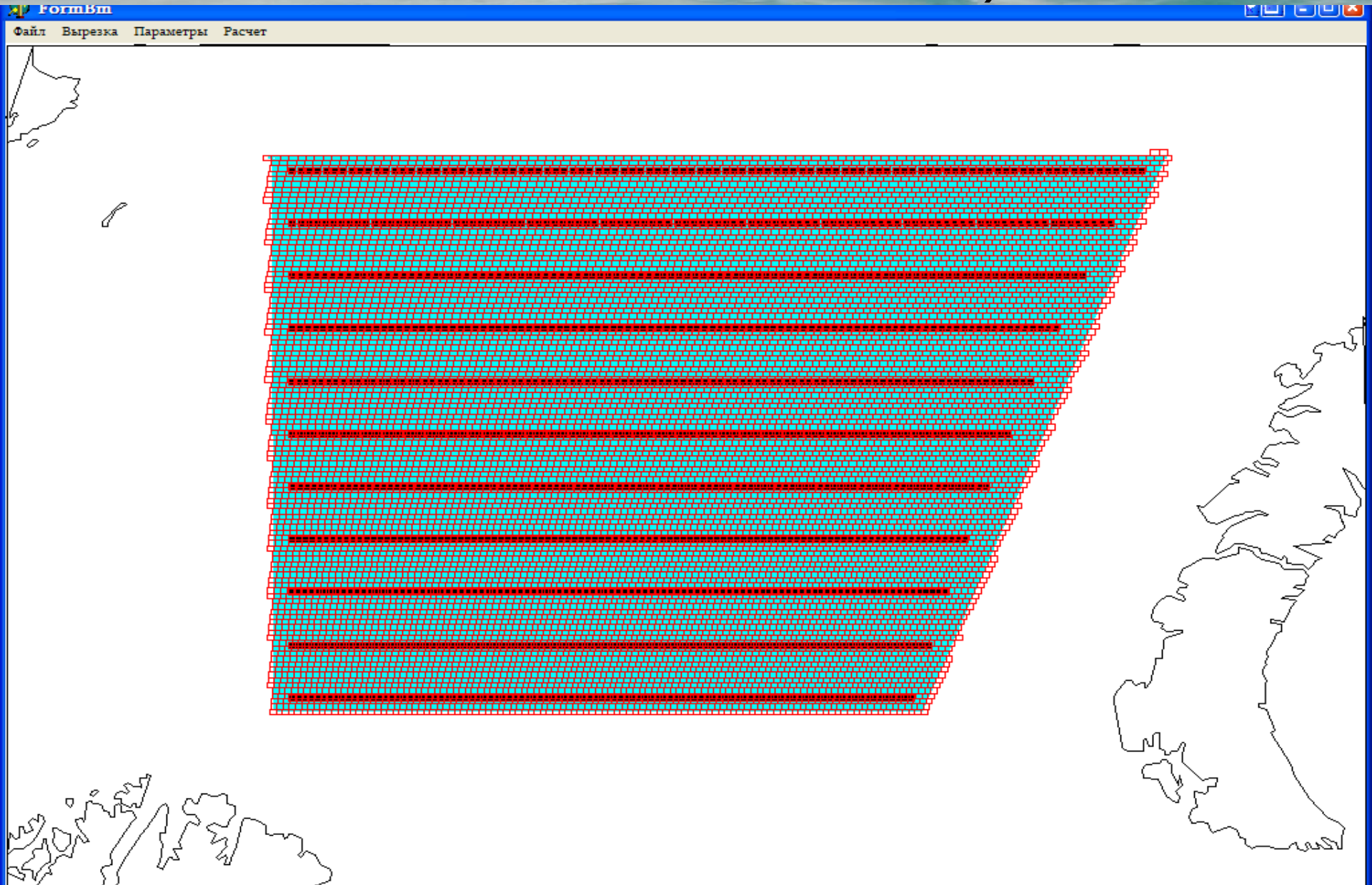
Probabilities of sized class in cell

$$\mathbf{M}=\sum_{i=1}^{T} N_i(X,Y)$$

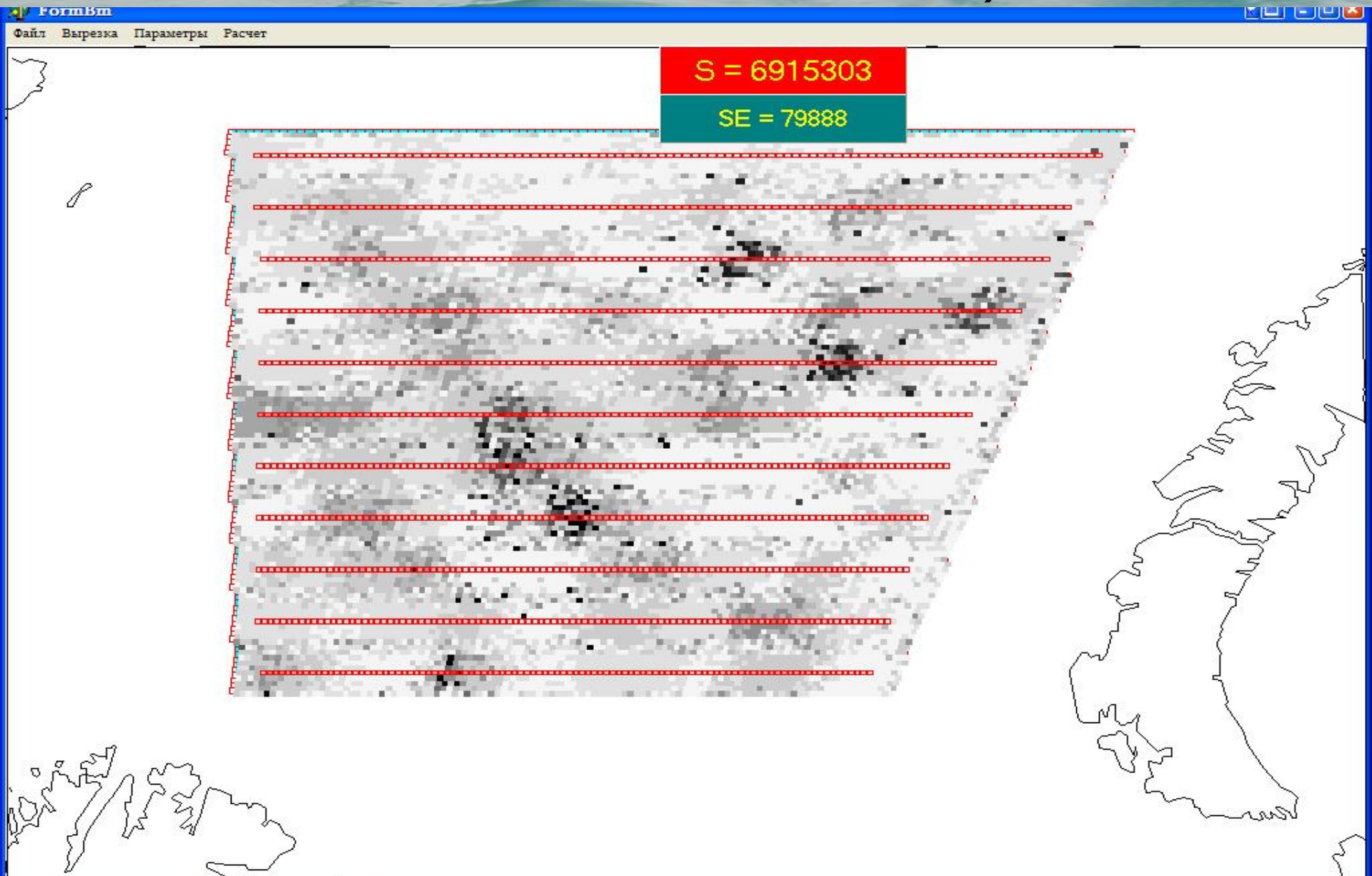
Moulting patches in 2005 (in example of harp seal in the White Sea)



Model of numbers calculation (in example of cod in the Barents Sea)



Model of numbers calculation (in example of cod in the Barents Sea)



Examples of calculations

Calculation of model

Type of distribution: group

True value	Method of average	Probabilistic method
6995585	6012943 (86%, -14%)	6759797 (97%, -3%)

Calculation of harp seals numbers on moulting patches

Type of distribution: aggregated

Date of aerial survey	Method of transect	Probabilistic method
April 23 2005	334872	401627 (+20%)
April 24 2005	319872	407026 (+27%)

The main advantages of probabilistic method

- absence of limitations which are connected with raw data collection (for example strong parallel transects, even distance between position of spots survey and so-on);
- opportunity to account biological peculiarities of biological objects distribution (marine mammals, sea birds, fishes and so-on) through weight coefficient;
- selection of region arbitrary limits for calculations of biological objects numbers on research area.