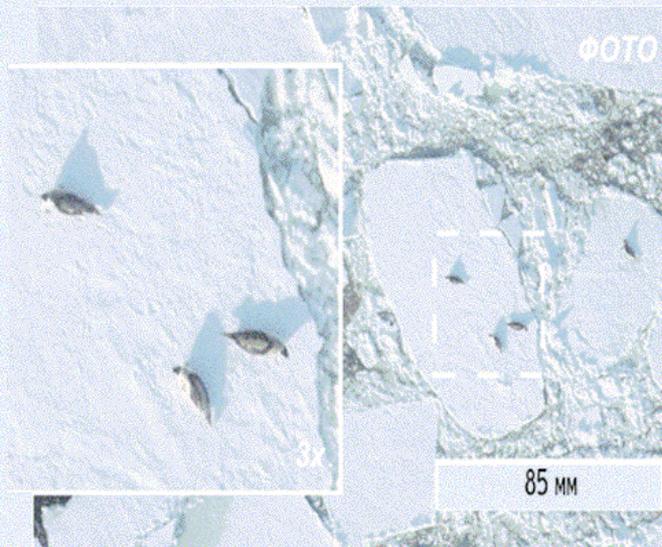


RESEARCH OF THE WHITE/BARENTS SEAS HARP SEAL POPULATION ON WHELPING PATCHES WITH USE OF MULTISPECTRAL AIR SURVEYS



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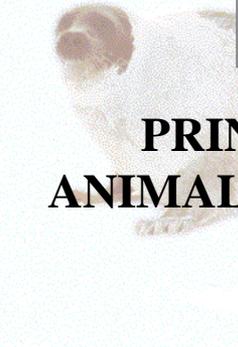


**THE 12th INTERNATIONAL CIRCUMPOLAR REMOTE
SENSING SYMPOSIUM; 14-18, MAY 2012;
LEVI, FINLAND**





PRINCIPAL RESEARCH OBJECTS: HARP SEAL, HERE CAN SEE ADULT ANIMAL (FEMALE) AND PUP (WHITE COAT) AMONG THE WHITE SEA ICES IN WHELPING TIME (PATCHES)



WHY RESEARCH THE WHITE/BARENTS SEAS HARP SEAL POPULATION IS NECESSARY AND WHY IN WHELPING TIME (PATCHES)?

- 1. THIS SEAL SPECIE POPULATION IS VERY IMPORTANT PART OF THE BARENTS AND WHITE SEAS ECOSYSTEM (THEIR TOTAL NUMBERS IS ABOUT 1.5 MILLION), THEY ARE PREDATOR OF TOP LEVEL FOR FISH. THEREFORE IT IS NEED TO KNOW STOCK SIZE OF HARP SEAL TO OPERATE RATIONALLY FISH STOCKS FOR FISHERIES ACTIVITY HERE;**
- 2. AT PRESENT HAS A CONSIDERABLE CLIMATIC CHANGE (WORMING DURING ABOUT LAST SEVEN YEARS) IN THE ARCTIC OCEAN WESTERN PART INCLUDING THE BARENTS AND WHITE SEAS. ALSO ABOVE AREA HAS HIGH LEVEL OF HUMAN ACTIVITIES (GAS AND OIL SEARCH AND EXTRACTION, NAVIGATION). THEREFORE IT IS NEED TO KNOW HOW THIS HUMAN ACTIVITIES INFLUENSE TO THIS SEAL STOCK;**
- 3. THE WHITE/BARENTS SEAS HARP SEAL POPULATION STOCK HAS COMMERCIAL SIGNIFICANCE. HE EXPLOITS BY RUSSIA AND NORWAY. THEREFORE IT IS NEED CORRECT SIZE THIS STOCK FOR THEIR RATIONAL AND SUSTAINABLE EXPLOITATION. THESE RESULTS IN THE INTERNATIONAL COUNCIL FOR THE EXPLOARATION^{OF} THE SEA (ICES) SPECIAL WORKING GROUP (WG) ARE PRESENTED AND DISCUSSED. HERE FINAL RECOMMENDATION ABOUT RATIONAL AND SUSTAINABLE EXPLOITATION ARE TOOK;**
- 4. WHELPING TIME (PATCHES) IS PERIOD WHEN FEMALES THIS SEALS BEAR REPLENISHMENT (SO NAMED PUP PRODUCTION). IT IS PERIOD BETWEEN END OF FEBRUARY AND END OF MARCH. THIS TIME IT IS THE MOST FAVOURABLE TO ASSESS WITH THE MOST CORRECT THE PUP PRODUCTION TOTAL NUMBERS. THIS PARAMETER IS PART AND VERY IMPORTANT IN CALCULATION OF THE WHITE SEA/BARENTS SEAS HARP SEAL POPULATION STOCK SIZE. THE MAIN REASON IT IS BIOLOGICAL PECULIARITIES PUP PRODUCTION ABOVE PERIOD, THEY DICTRIBUTE ON ICE ONLY AND DON'T GO TO THE OPEN WATER.**

WHY AIRBORNE MULTISPECTRAL METHOD IS PROPOSED FOR RESEARCH?

- 1. DURING WHELPING TIME ON PATCHES PUPS HAVE WHITE COLOUR, AND AROUND THEIR ICE AREA IS COVERED BY SNOW AND IT HAS WHITE COLOUR ALSO. THEREFORE IF USE STANDARD PHOTO – VIDEO METHOD WE CAN MISS SOME NUMBERS OF PUPS ON SNOW MASKED REASON EFFECT;**
- 2. ABOVE PROBLEM CAN BE SOLVED IF USE INFRARED EQUIPMENT, FOR EXAMPLE INFRARED SCANNER (IR-SCANNER) SIMULTANEOUSLY WITH PHOTO- AND VIDEO CAMERAS. IR-SCANNER ALLOWS TO DETECT AND RECORD PUPS AMONG ICES AS BRIGHTNES SPOTS. PRINCIPAL REASON IT IS DIFFERENCE TEMPERATURES BETWEEN ICE AND PUP'S BODY WHICH RECOD BY IR-SCANNER. THEREFORE IF USES TWO TYPES OF REMOTE SENSING EQUIPMENTS (PHO- VIDEO CAMERAS AND IR-SCANNER) FOR ONE RESEARCH OBJECT (PUPS) THIS METHOD WAS TITLED AS MULTISPECTRAL. BESIDES, USING SPESIAL AIRCRAFT EQUIPPED BY ABOVE REMOTE SENSING EQUIPMENTS (RESEARCH AIRCRAFT) ALLOW TO GET ALL NECESSARY INFORMATION FROM VAST AREA (THE WHITE SEA AND THE BARENTS SEA ADJACENT PARTS) FOR VERY SHORT TIME;**
- 3. ABOVE METHOD USES BY PINRO BEGINNING FROM 1997 AND IT WAS RECOGNISED BY ICES SPECIAL WG ON THE HARP AND HOODED SEAL (WGHARP) AS HIGH QUALITY METHODS;**
- 4. USUALLY UNDER WGHARP RECOMMENDATIONS AERIAL SURVEYS OF THE WHITE/BARENTS SEAS POPULATION ON WHELPING PATCHES (TIME) NOT RARE THAN ONE TIME PER 2-3 YERS ARE CARRIED OUT. THIS REASON LAST WAS CARRIED OUT IN 2010**



APPEARANCE OF RESEARCH AIRCRAFT ANTONOV-26 NAMED “ARKTIKA” (“ARCTIC” IN ENGLISH) AND IT MAIN TECHNICAL SPECIFICATIONS

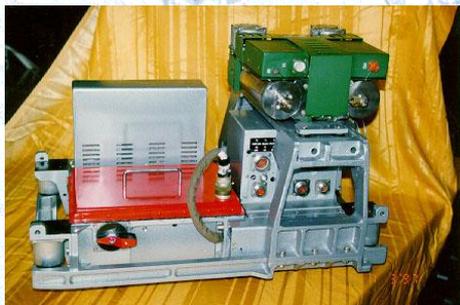
<i>MAXIMUM FLIGHT LENGTH, N. MILES</i>	<i>1 500</i>
<i>MAXIMUM FLIGHT DURATION, H</i>	<i>10</i>
<i>NUMBERS OF ONBOARD MEASURING EQUIPMENTS</i>	<i>(HARP SEAL-8) MAX.-14</i>
<i>NUMBERS OF PLACES FOR ONBOARD OPERATORS</i>	<i>8</i>
<i>ALTITUDE, M</i>	<i>100-6000</i>
<i>SPEED, KNOTS</i>	<i>170</i>

RESEARCH AIRCRAFT “ARKTIKA” REMOTE SENSING EQUIPMENTS AND ITS TECHNICAL SPECIFICATIONS



Digital Camera «Nikon D1X»

- | | | |
|----|---------------------------|--------------|
| 1. | <i>Image Size, pic.</i> | 3008x1960 |
| 2. | <i>Die Size, pic.</i> | 5,470,000 |
| 3. | <i>Sensitivity, ISO</i> | 125-800 |
| 4. | <i>Exposure, s</i> | 30 – 1/16000 |
| 5. | <i>Focus Distance, mm</i> | 28 – 80 |



IR-scanner “Malakhit”

- | | | |
|----|------------------------------------|------|
| 1. | <i>Horizontal Resolution, mrad</i> | 1.55 |
| 2. | <i>Field of View, °</i> | 120 |
| 3. | <i>Sensitivity, C</i> | 0.1 |
| 4. | <i>Maximum Scan Rate, Hz</i> | 125 |
| 5. | <i>Dynamic Range, bits</i> | 12 |



Video System «Panasonic»

- | | | |
|----|-----------------------------------|---------------|
| 1. | <i>Die Size, pic.</i> | 1,080,000 |
| 2. | <i>Standard Illumination, lux</i> | 1400 |
| 3. | <i>Exposure Range, s</i> | 1/50 – 1/8000 |
| 4. | <i>Focus Distance, mm</i> | 3.55 – 35.5 |



**INFORMATION WHICH IN PREPARING, PLANNING AND
AERIAL RESEARCHES CARRYING OUT
IN MIDDLE OF FEBRUARY TO END OF MARCH IN 2010 WERE USED**

I. The main sources: Internet and Free - from our partners as specially.

II. Types of information, from the White Sea and the Barents Seas adjacent area:

1. About current and forecasted ice conditions,
2. For ice drift control,
3. About current and forecasted synoptic situation.

III. Institutes, organizations and companies:

USA: NOAA National Ice Centre (Internet, 1) – NOAA NIC; NOAA Air Research Laboratory (Internet, 3) – NOAA ARL; NASA – Rapid Response-LANCE from Terra/MODIS and Aqua/MODIS (Internet, 1);

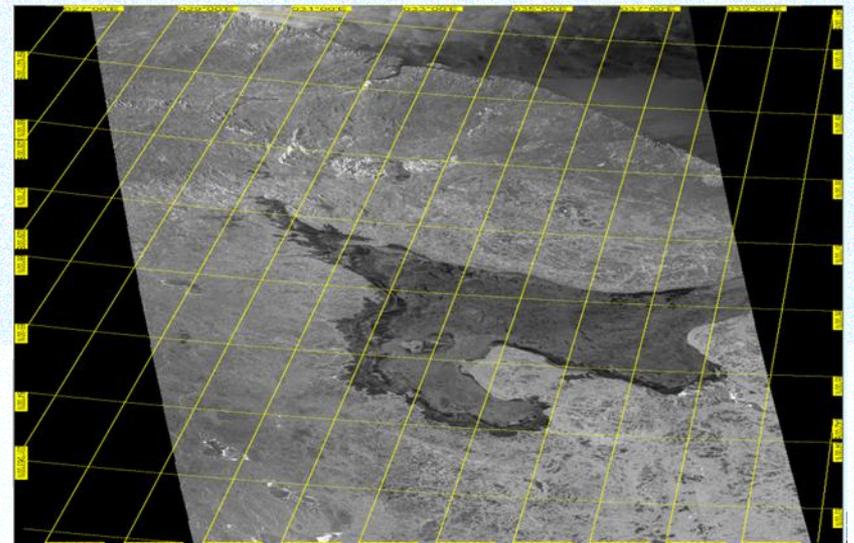
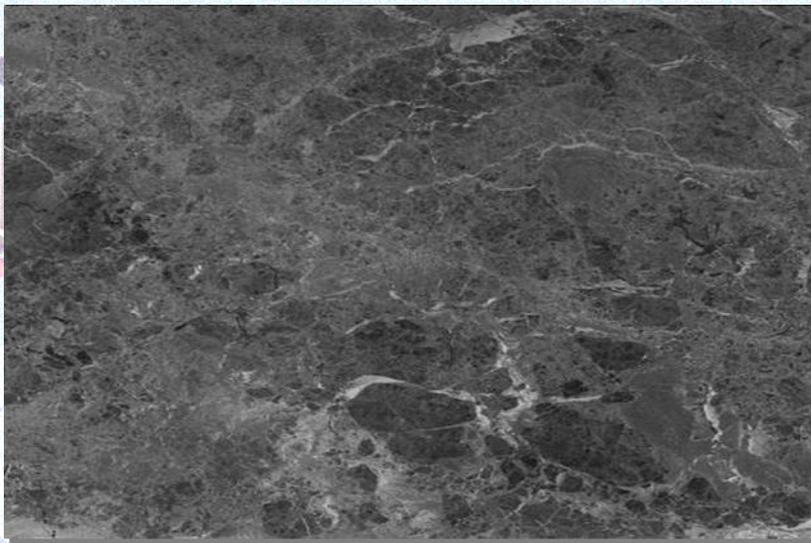
Norway: Meteorological Institute (Internet, 1, 3) - NMI;

Germany: Wetterzentrale Stroer Interactive GmbH (Internet, 3) - WSI;

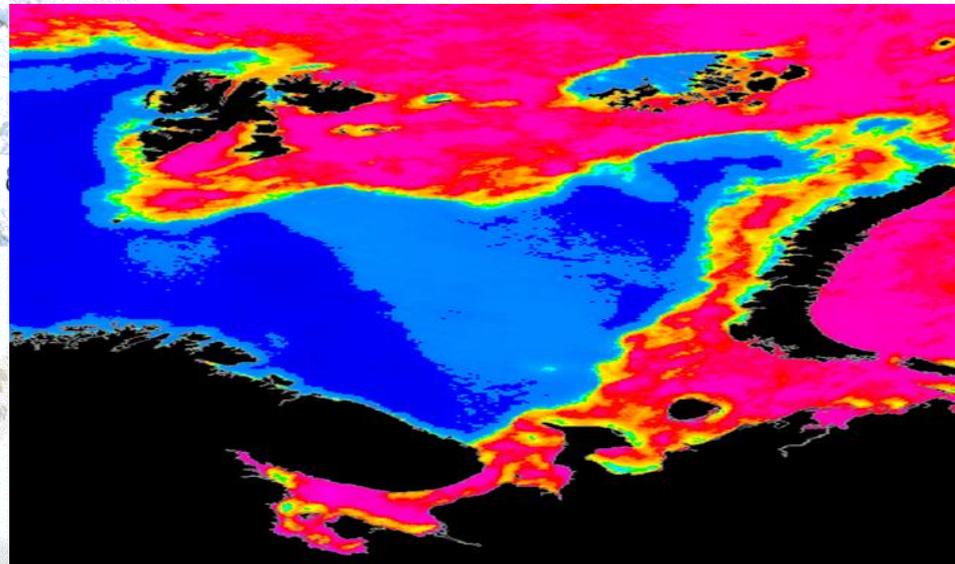
Denmark: Sea Ice Information System from Technical University (Internet, 1) - DTU;

Russia: Arctic and Antarctic Research Institute (Internet, 1, 2) – AARI; Russian Hydro Meteorological Centre (Internet, 1, 3) - RHMC; Northern Hydro Meteorological Centre (Free, 1-3) – NHMC; ScanEx Information-Technical Centre (Free, 1) - SEITC.

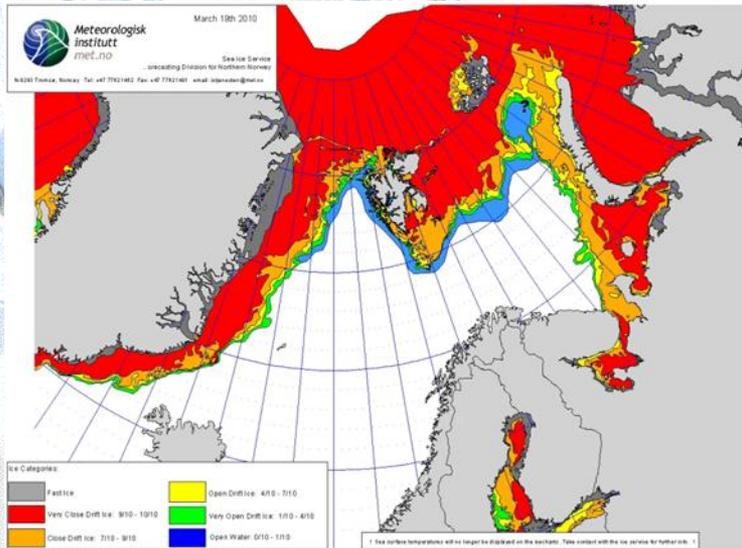
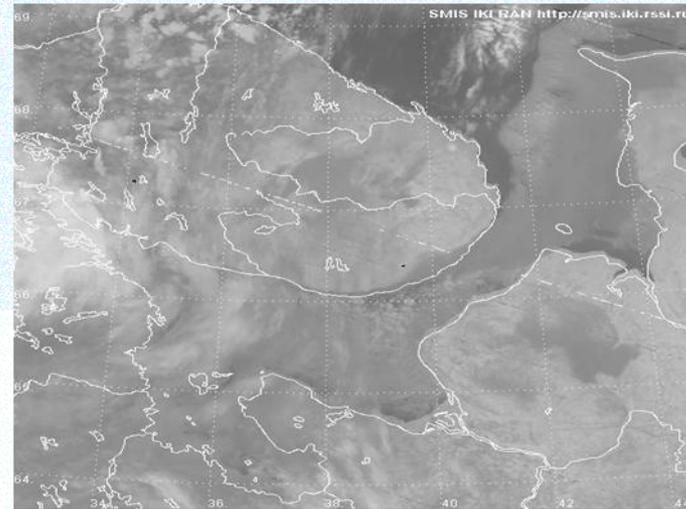
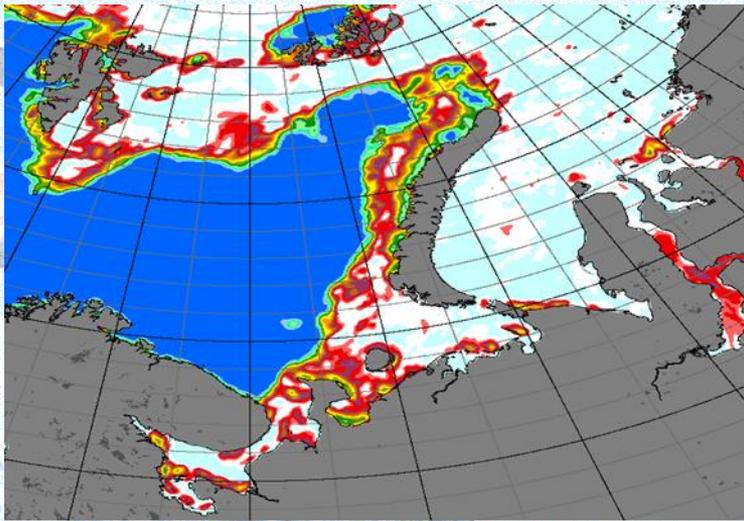




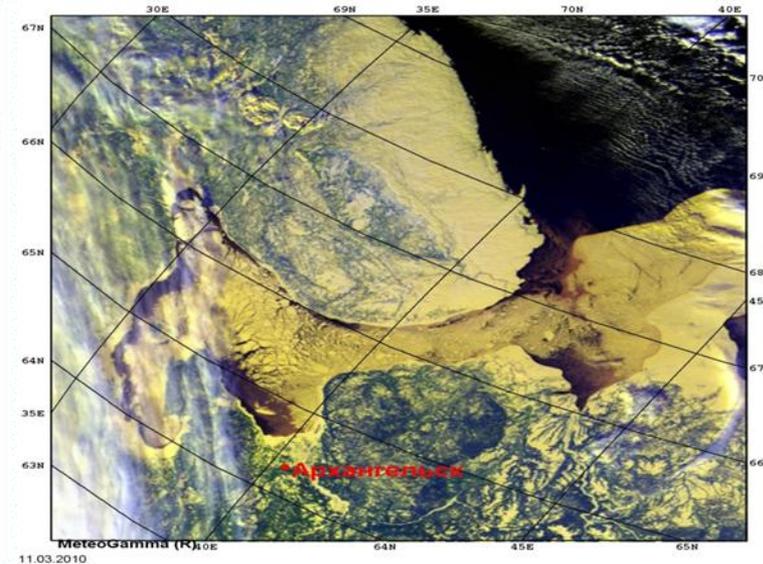
**EXAMPLES OF RARARSAT IMAGE FROM SEITC IN MARCH 22, 2010
(RIGHT – FULL IMAGE, LEFT – PART OF IT - INCREASED)**



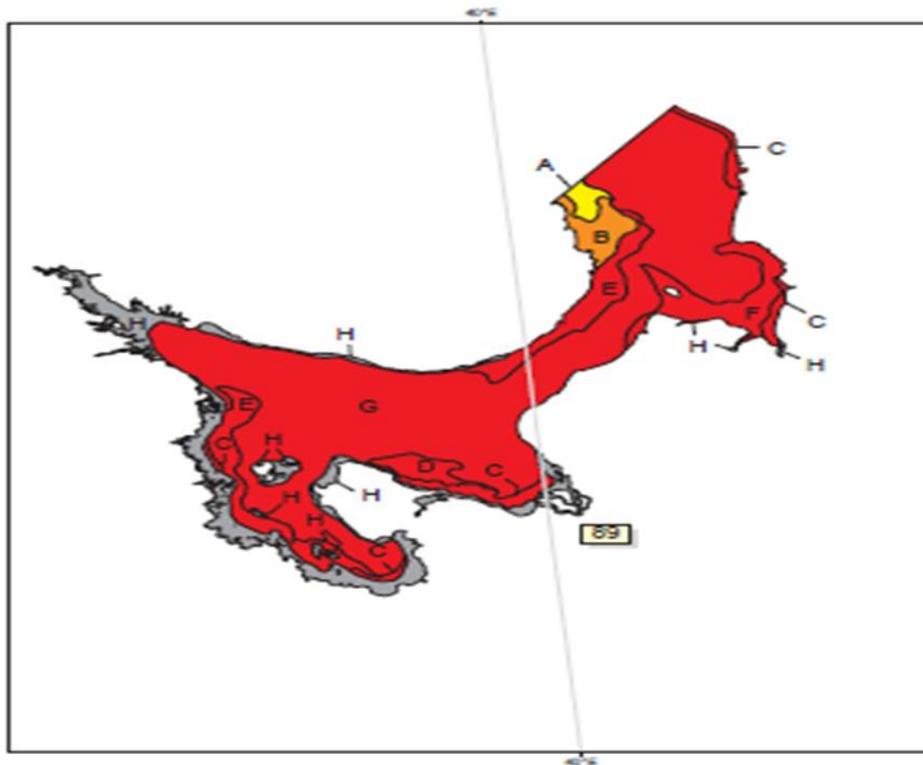
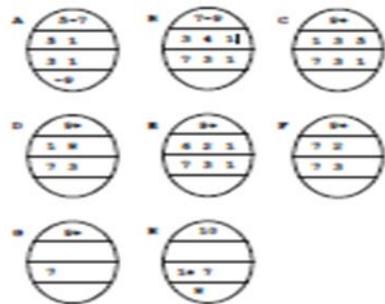
EXAMPLE OF SSM/I IMAGE FROM DTU IN MARCH 21, 2010



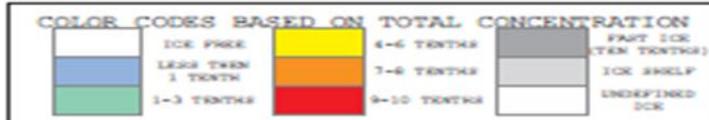
Ледовая обстановка в Белом море по данным ИСЗ 11.03.2010 11.55 мск



EXAMMPLES WITH ICE CONDITIONS IMAGES, 1. TOP: LEFT – AARI (MARCH 22, 2010), RIGHT – RHM CENTER (MARCH 22, 2010); 2. BOTTOM: LEFT – NMI (MARCH 19, 2010), RIGHT – NHMC (MARCH , 11 2010)



CM = THEORETICAL ICE THICKNESS IN CENTIMETERS

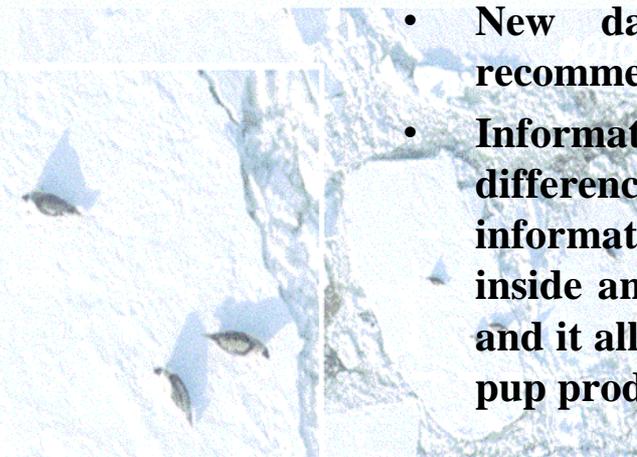


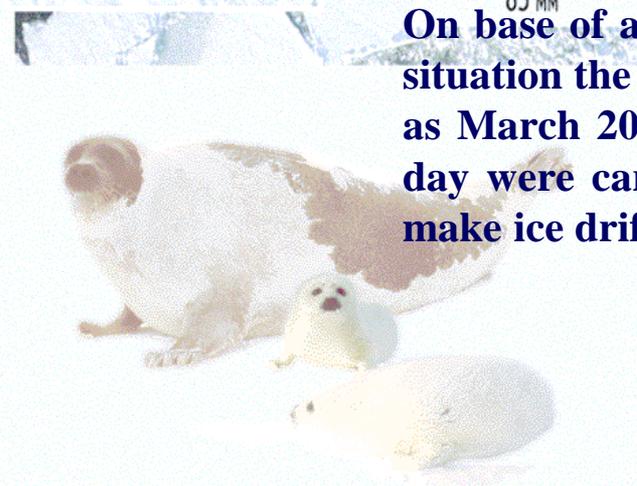
ICE ANALYSIS
White Sea
NATIONAL/NAVAL ICE CENTER
 Analysis Week 15 - 19 Mar 2010
 Data Sources Date
 RADARSAT.....14 Mar
 OLS.....15 Mar
 Analysts: Lanehart, Christopher AG2
UNCLASSIFIED

EXAMPLE OF COMPLEX ICE MAP FROM NOAA NIC (15-19 MARCH, 2010)



SPECIAL ADDITIONAL INFORMATION WHICH WERE USED IN PREPARING AND PLANNING OF AERIAL RESEARCHES TOGETHER WITH ABOVE INFORMATION

- 
- **New data by harp seal biological parameters and WGHARP recommendations;**
 - **Information from aircraft L-410 flights which in March 8, 15, and 19 in difference parts of the White Sea were carried out with other purposes but information by harp seal whelping patches distribution including situation inside and outside their (in the first by whelping activities) was collected, and it allow to consider these flights as reconnaissance for future harp seal pup production multispectral aerial researches with full basis.**



On base of above both information including current and forecasted synoptic situation the most optimum time of multispectral aerial researches was defined as March 20-23, 2010. Aerial research flights was 4 in total, and they every day were carried out that allowed to exclude repeated harp seals count and make ice drift control.

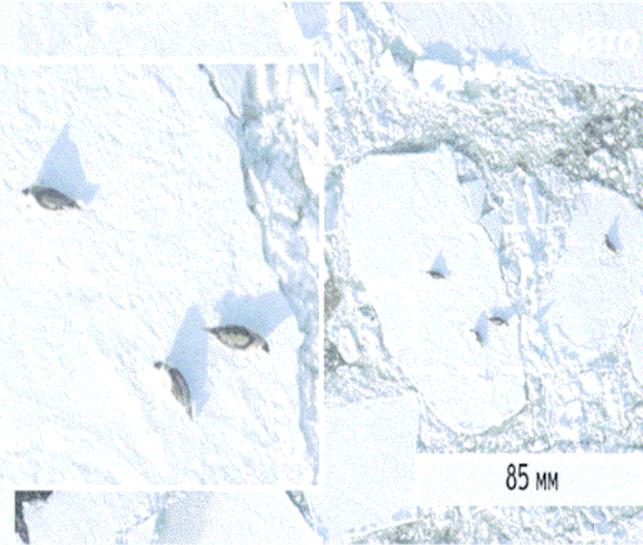
PRINCIPAL REQUIREMENTS FOR HIGH QUALITY MULTISPECTRAL AERIAL SURVEYS CARRYING OUT BY WEATHER CONDITIONS



- Wind speed – no more than 10 m/s;
- Absolute absent of precipitations, fogs, haze and other atmospheric phenomenon;
- Clouds low edge – higher than 250 m.

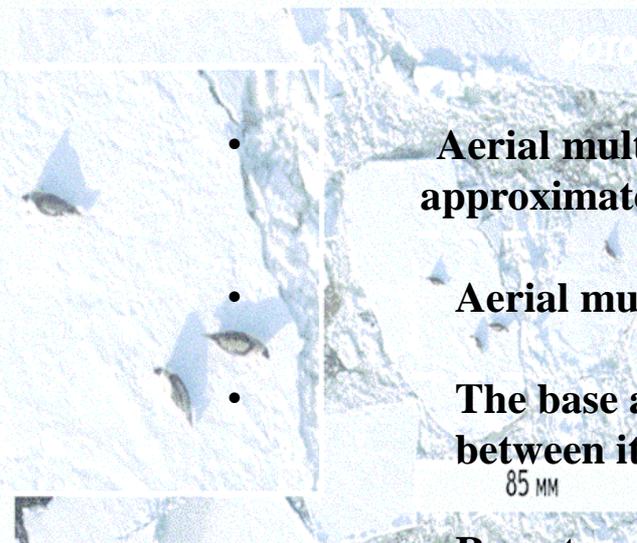
Its meteorological conditions should observe in area more than 75% of aerial survey area simultaneously.

Above situation in each aerial survey fulfilling was observed in March 2010.

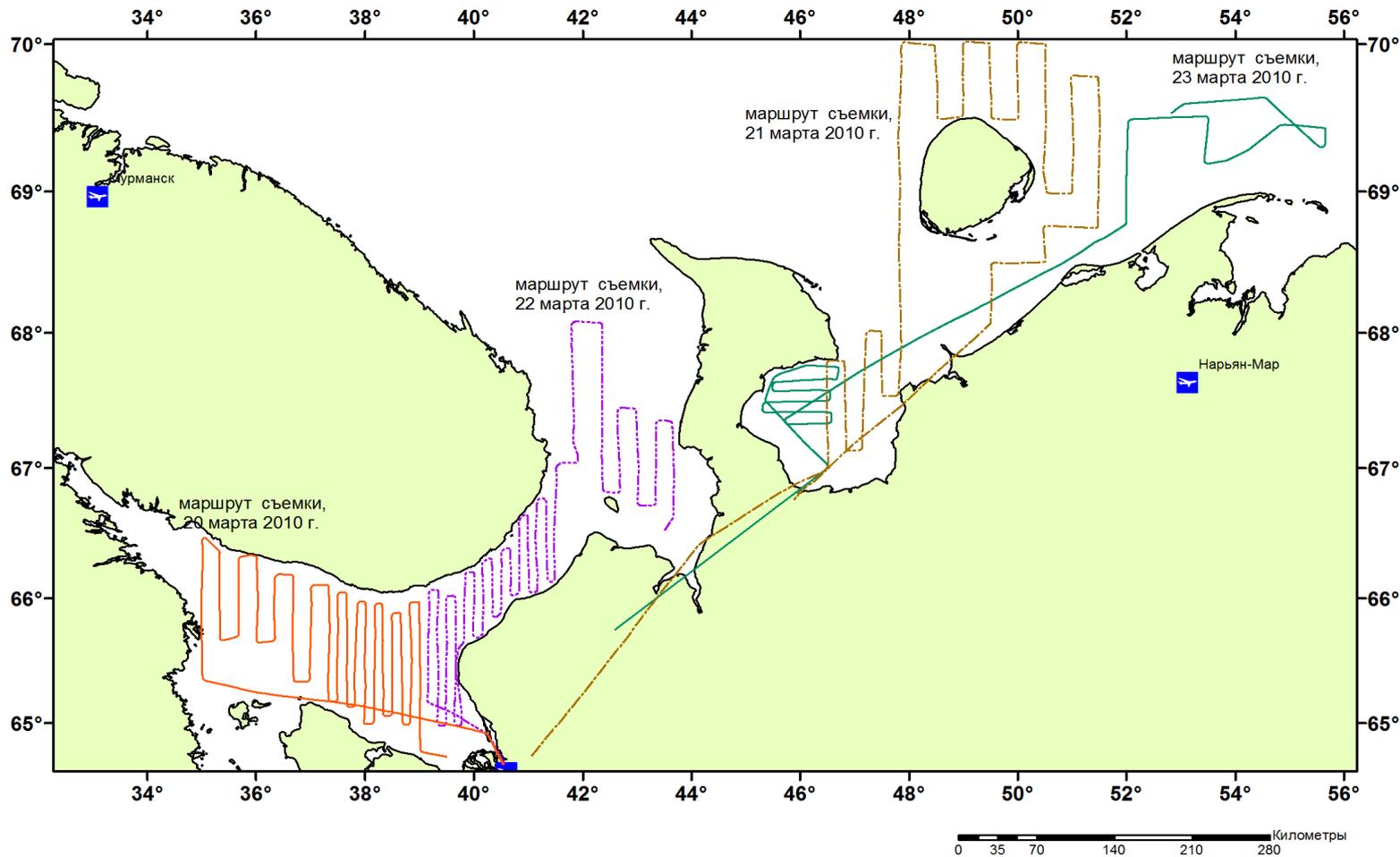




DATA ON RESEARCH AIRCRAFT “ARKTIKA” EXPLOITATION IN MARCH 2010

- 
- **Aerial multispectral surveys altitude was 200 – 250 m, in principal approximately 230– 250 m;**
 - **Aerial multispectral surveys flight speed was 300-320 km/h;**
 - **The base accounted tracks were oriented along longitudes with distance between its 7.5-10.0 km, i.e. about 10’ between longitudes or few more;**
 - **Remote sensing equipment switched on when ice edge was crossed from open water and switched off when research aircraft reached coast or crossed ice edge again from ice edge again to open water.**
- 

DATES AND TRACKS OF AERIAL RESEARCH IN EACH AERIAL MULTISPECTRAL SURVEY FOR HARP SEAL PUP PRODUCTION DISTRIBUTION AND NUMBER STUDY



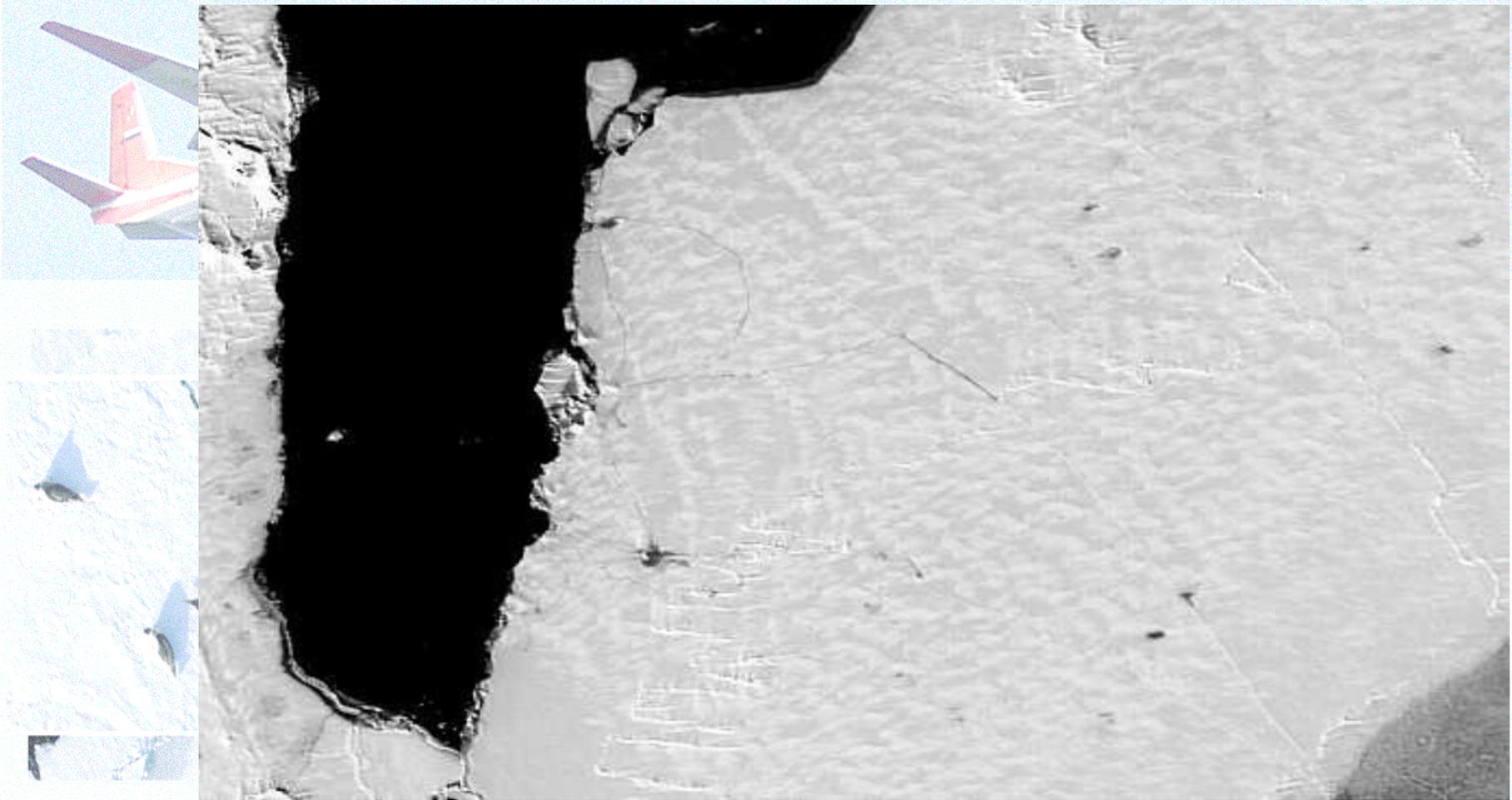
GENERALIZED INFORMATION ABOUT CONSIDERED AERIAL RESEARCH

1. Total duration of harp seal whelping patches multispectral aerial surveys was 32.5 h;
2. Rough information and data along tracks with total extent about 9 500 km was got and area 4 750 km² with remote sensing equipment using and visual observations was truly investigated;
3. Total square of area was about 8 500 km² where aerial researches were carried out, and it included:
 - the White Sea area with all main gulfs and bays where can be recorded harp seal whelping patches, so named traditional areas,
 - the Barents Sea south-eastern part which was adjacent to the White Sea, and in the first it is areas where harp seal whelping patches could be waited under ice conditions (areas around Kolguev Island and in the Cheshskaya Bay in the Pechora Sea western part) which by WGHARP in 2008 and 2009 were recommended, so named new not traditional areas;
4. Total volume of rough data and information collected during aerial researches was following:
 - digital photos – more than 31 000 pieces,
 - IR-images – more than 120 Gb,
 - video-images – more than 18 hours,
 - audio-recording – more than 20 h.

Future calculation of total pups abundance by standard the M. Kingsly method was made.

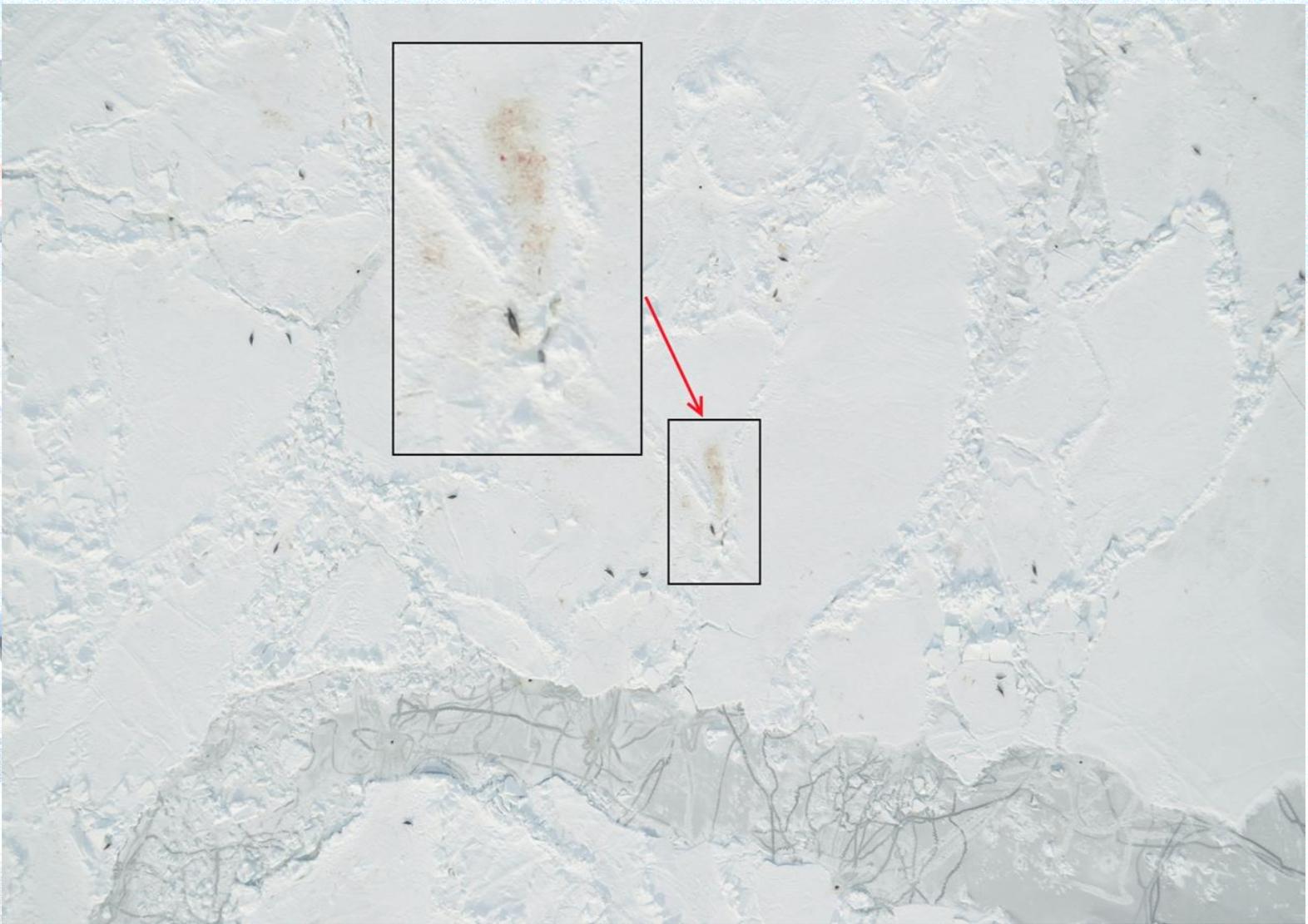
MAIN CONCLUSIONS BY ICE CONDITIONS BEFORE AND DURING AERIAL MULTISPECTRAL SURVEYS IN MARCH 2010

- 1. Ice conditions was the same as climatic in whole, it was first time for last 7-8 years, i.e. dates of ice creation, total area of ice cover, and ice period duration were closely for average many years data, it was end of December-beginning of January, 75-85%, and 125-135 days, accordingly;*
- 2. Ice drift in the White Sea during aerial researches carrying out and also short time before and after them was inside, carrying out of ices to the Barents Sea was slight or completely absented practically during March 10-30. This situation favoured to maximum whelping patches conservation inside of the White Sea.*
- 3. The most density of harp seal whelping patches creation in areas covered by first-year ice with thickness 50-70 cm, concentration 70-90%, and numerous standing floe was recorded. Here ice forms were small floe and floe which were by superficial and dense snow were covered. Whelping patches inside ice massif were distributed.*
- 4. In the Barents Sea south-eastern part adjacent area including Cheshskaya Bay, area around Kolguev Island, and⁸⁵ eastward of them ice conditions were unfavourable for the White Sea/Barents Sea harp seal pup production creation under satellite information. Here ice concentration was 90-100% in lack of polynya, large cracks and fractures. This fact in aerial survey results carried out in March 23 was in full confirmed.*



**EXAMPLE OF SATELLITE IMAGE FROM SEITC IN MARCH 22, 2010 (EROS-B
WITH SPATIAL RESOLUTION 0,8 M)**





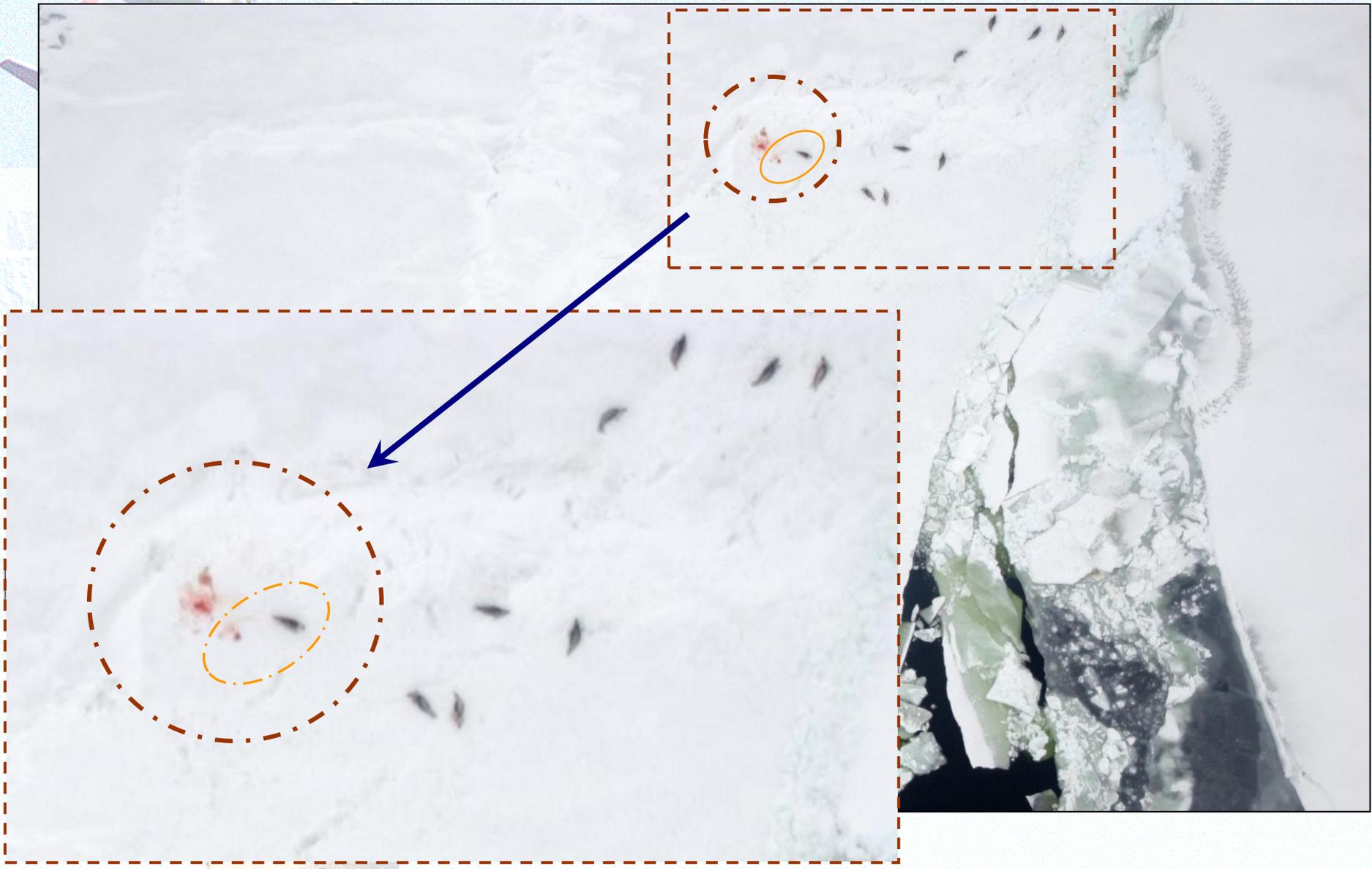
**EXAMPLE OF HARP SEAL PUPPING BY RECONNAISSANCE FLIGHTS
(FROM MARCH 19, 2010)**

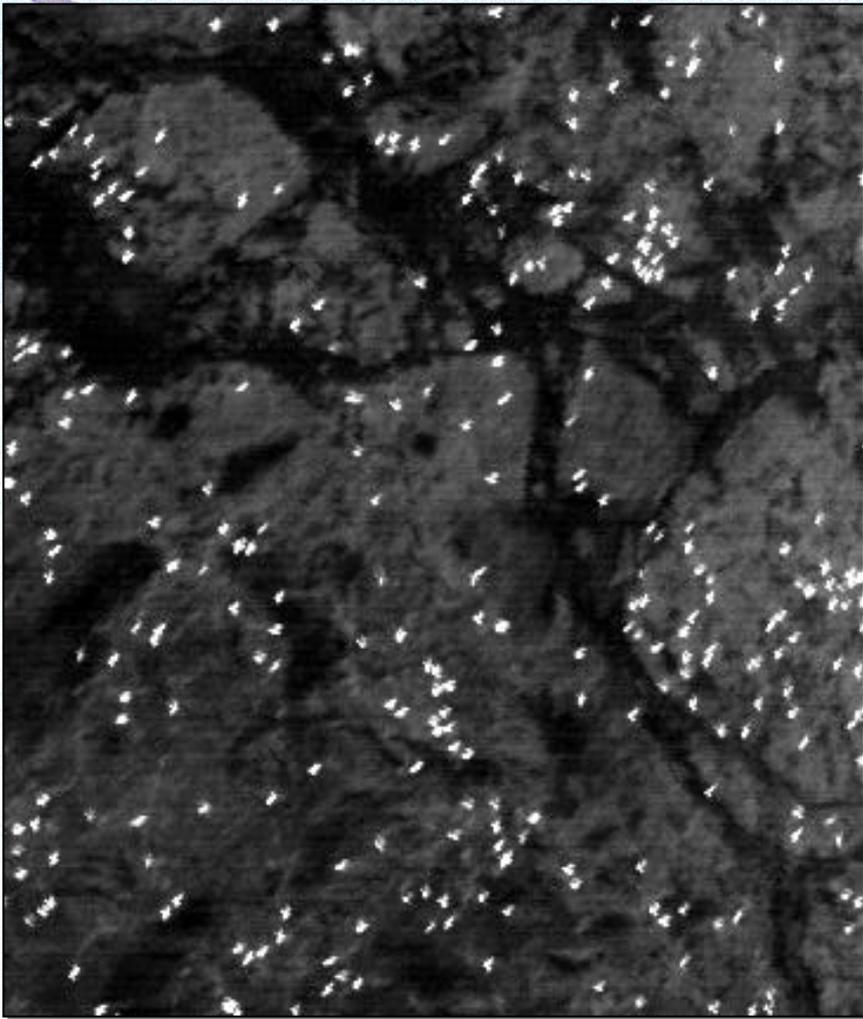




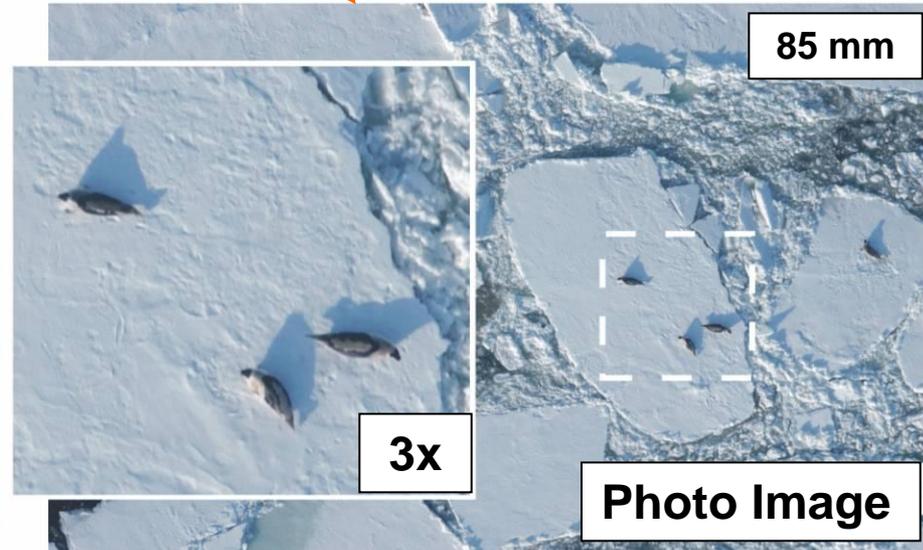
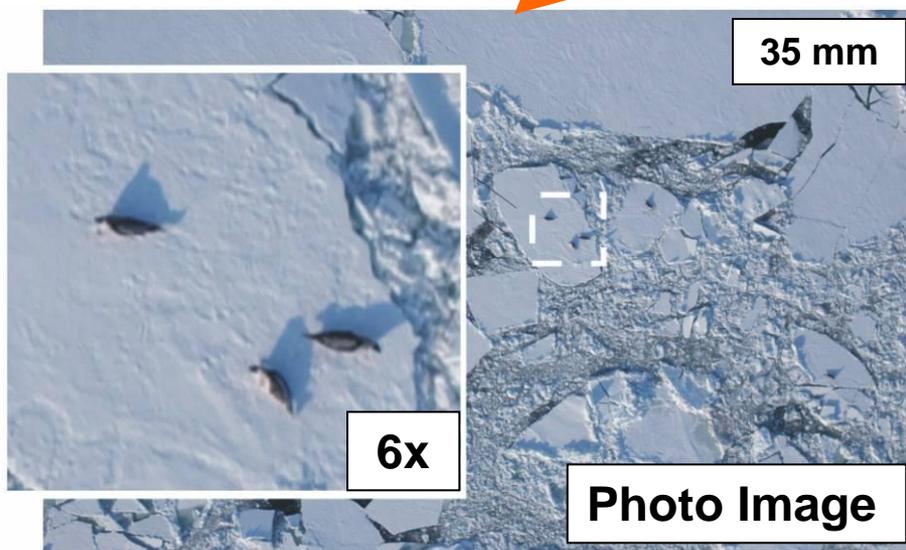
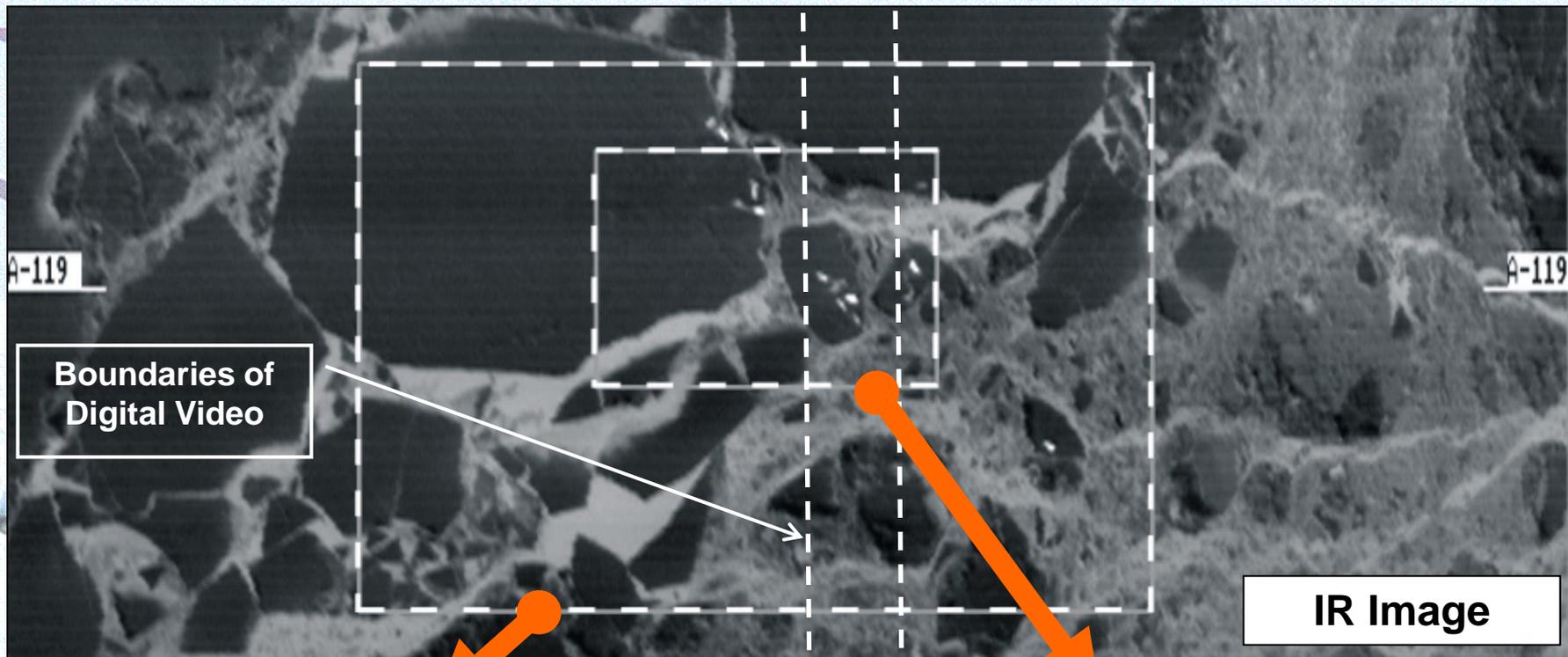
EXAMPLE OF WHELPING PATCH WITH THE MOST CONVINIENT ICE CONDITIONS IN MARCH 2010

EXAMPLE OF HARP SEAL WHELPING PATCH IN 20 MARCH 2010

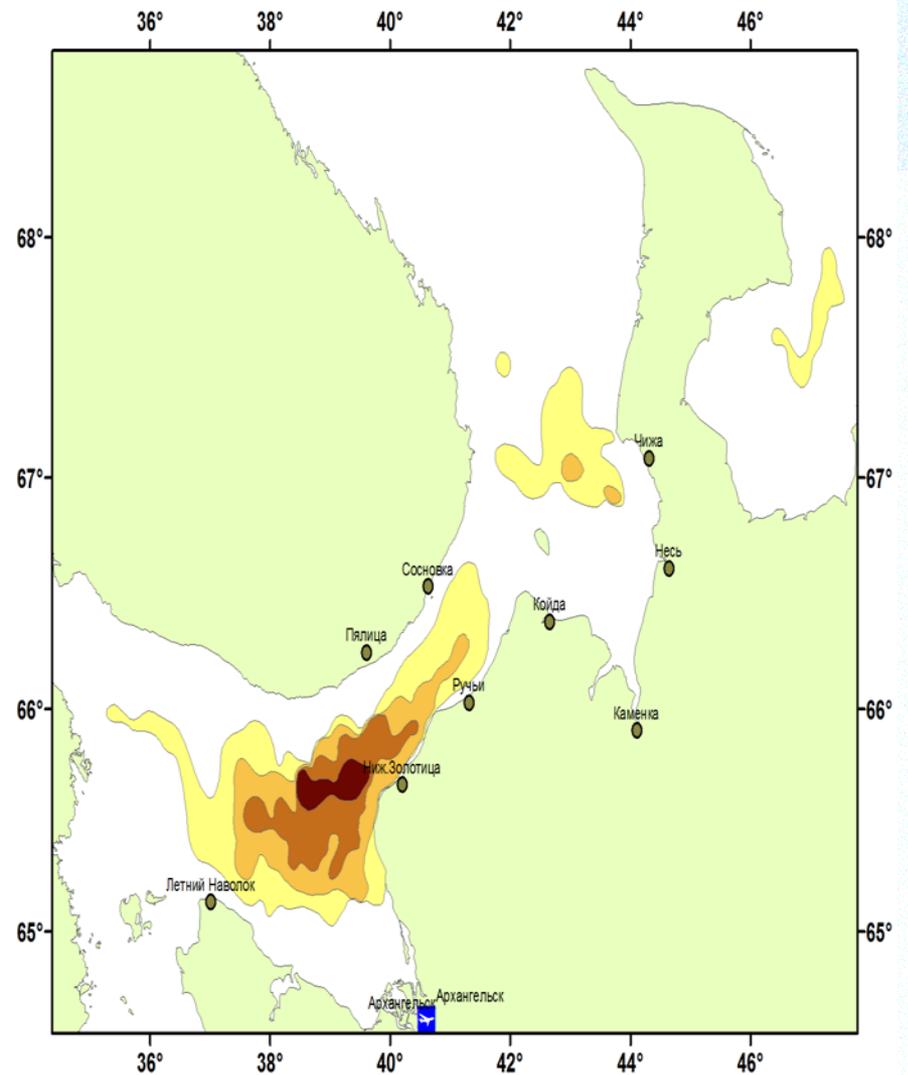
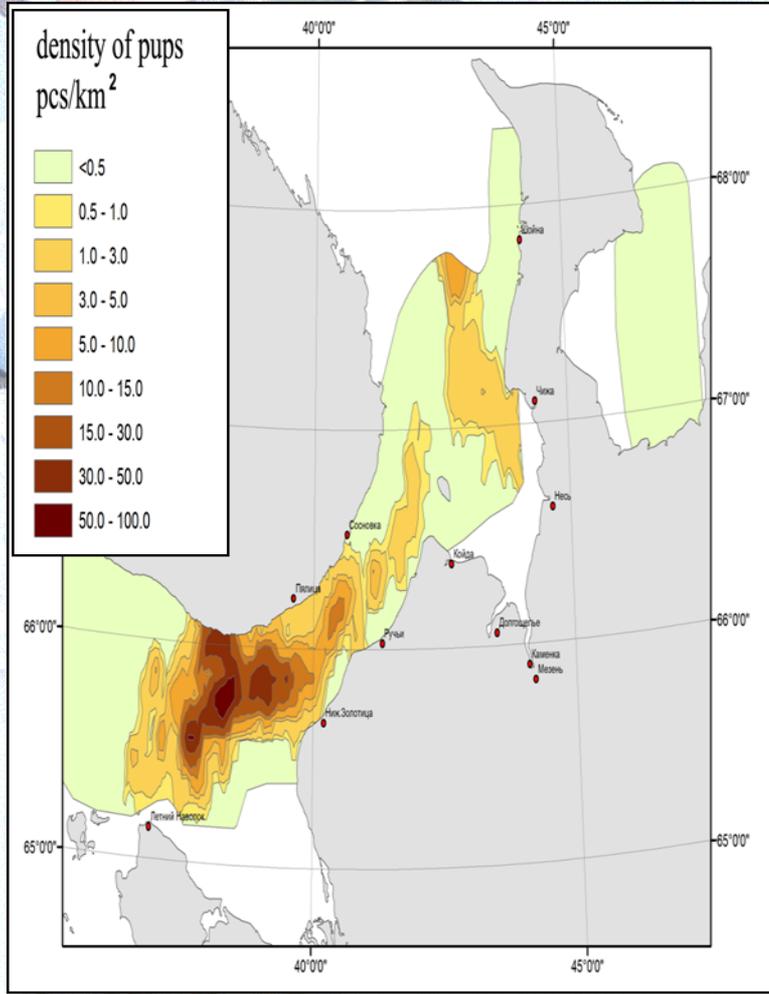




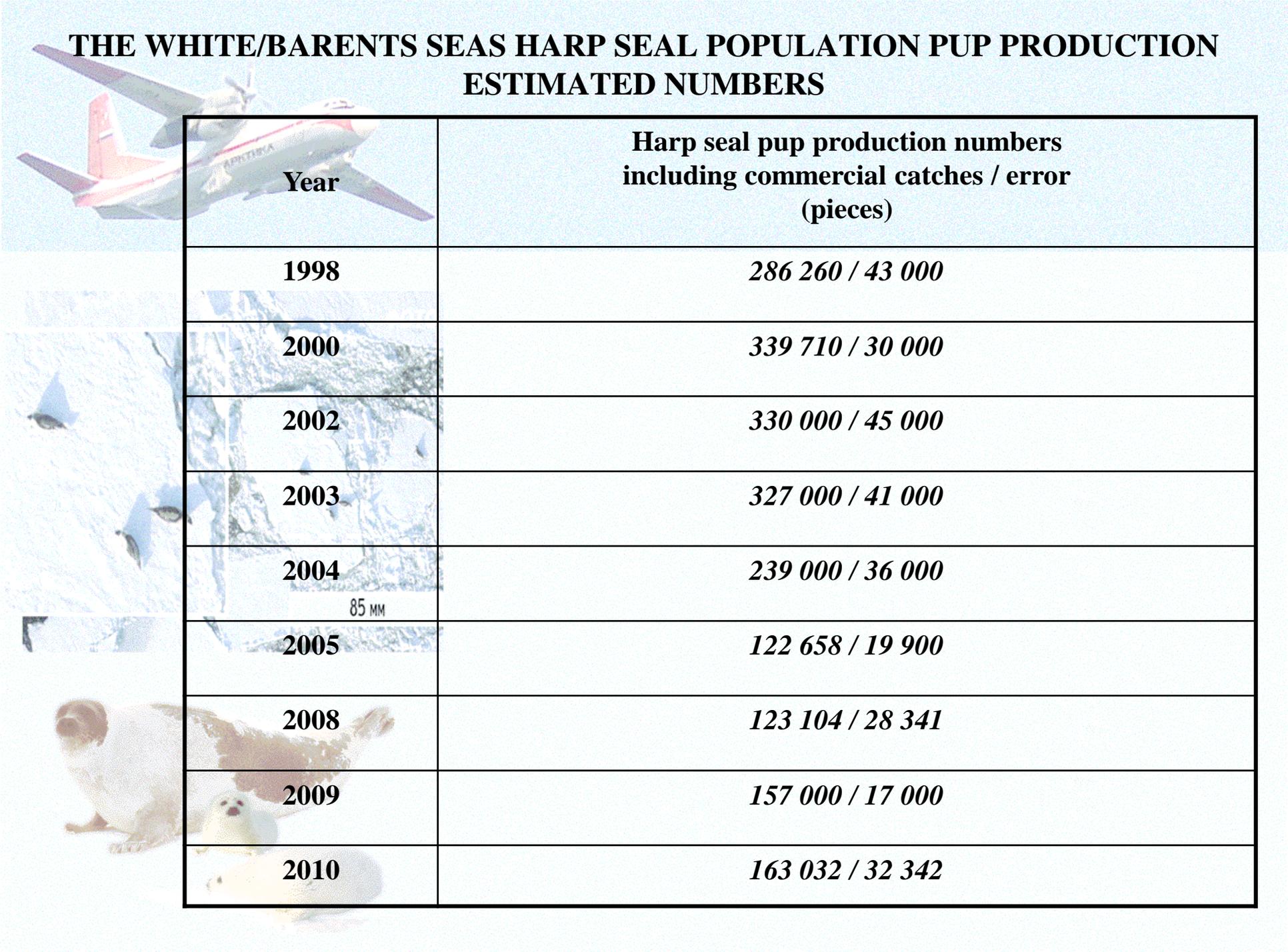
EXAMPLES OF HARP SEAL WHELPING PATCHES IN IR-IMAGE (LEFT) AND PHOTO (RIGHT). PATCHES IN IR-IMAGE ARE HIGH DENSITY, AND PHOTO ARE MIDDLE DENSITY



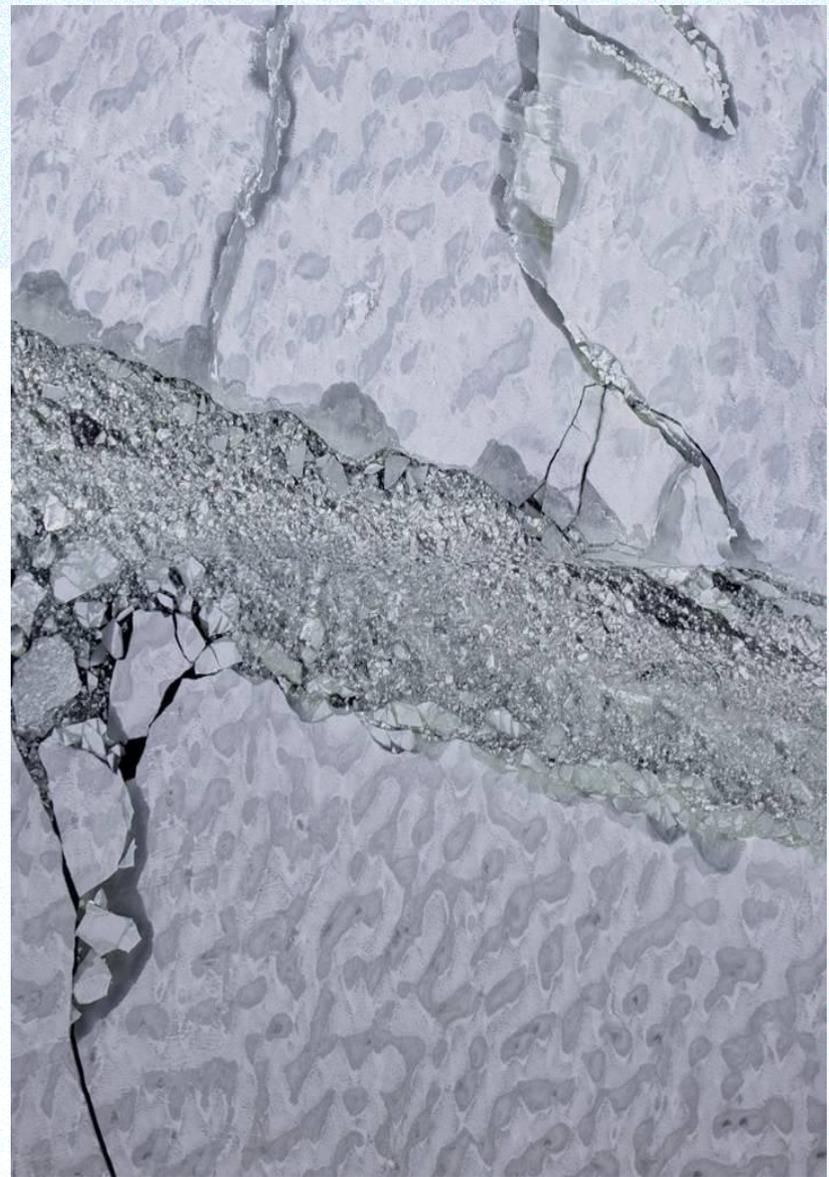
DENSITIES OF PUP PRODUCTION WHELPING PATCHES DISTRIBUTION IN 2009 (LEFT) AND IN 2010 (RIGHT)



THE WHITE/BARENTS SEAS HARP SEAL POPULATION PUP PRODUCTION ESTIMATED NUMBERS



Year	Harp seal pup production numbers including commercial catches / error (pieces)
1998	<i>286 260 / 43 000</i>
2000	<i>339 710 / 30 000</i>
2002	<i>330 000 / 45 000</i>
2003	<i>327 000 / 41 000</i>
2004	<i>239 000 / 36 000</i>
2005	<i>122 658 / 19 900</i>
2008	<i>123 104 / 28 341</i>
2009	<i>157 000 / 17 000</i>
2010	<i>163 032 / 32 342</i>

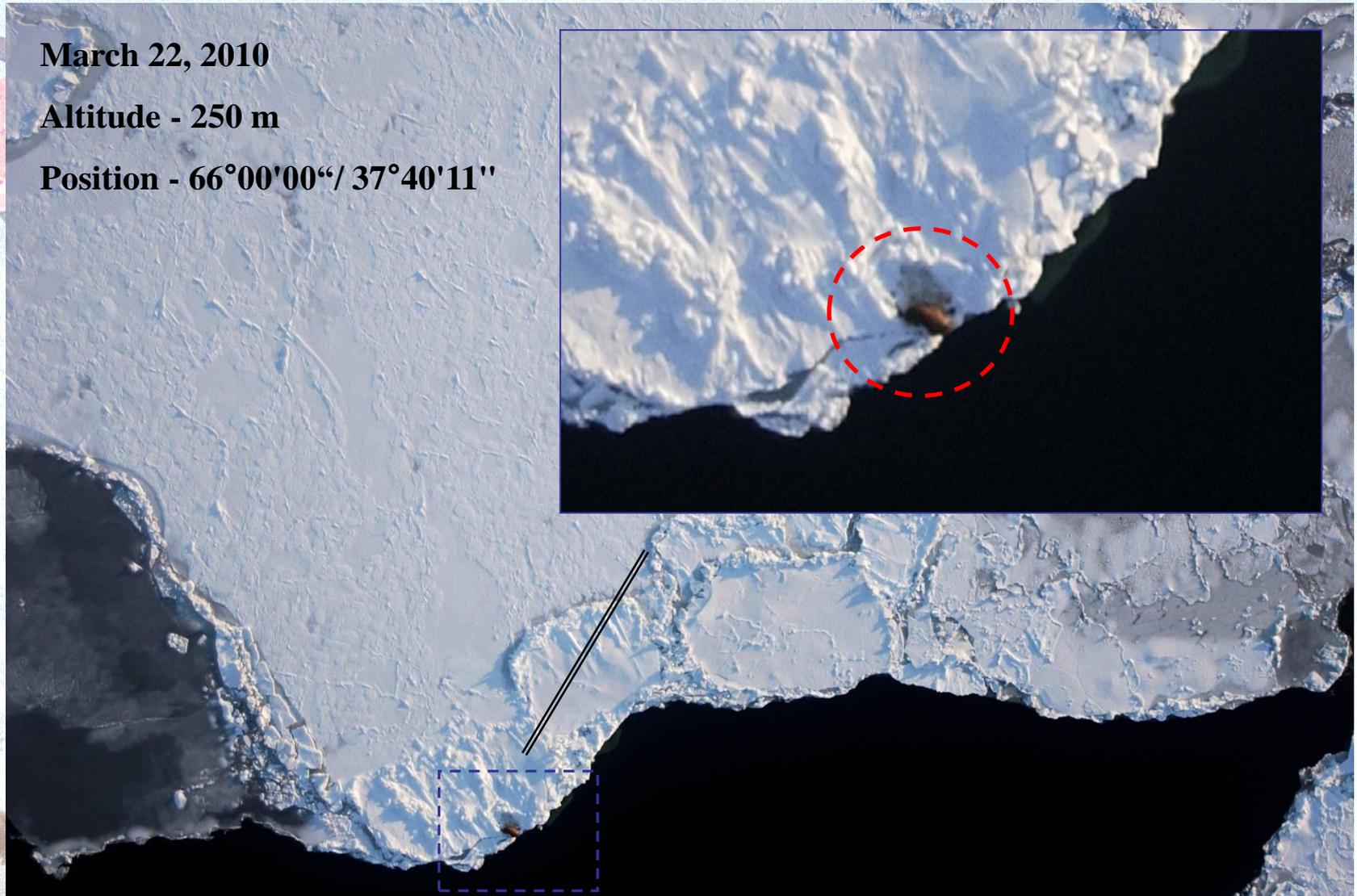


**EXAMPLE OF ICEBREAKER TRACK FROM RESEARCH
AIRCRAFT "ARKTIKA"**

March 22, 2010

Altitude - 250 m

Position - 66°00'00"/ 37°40'11"



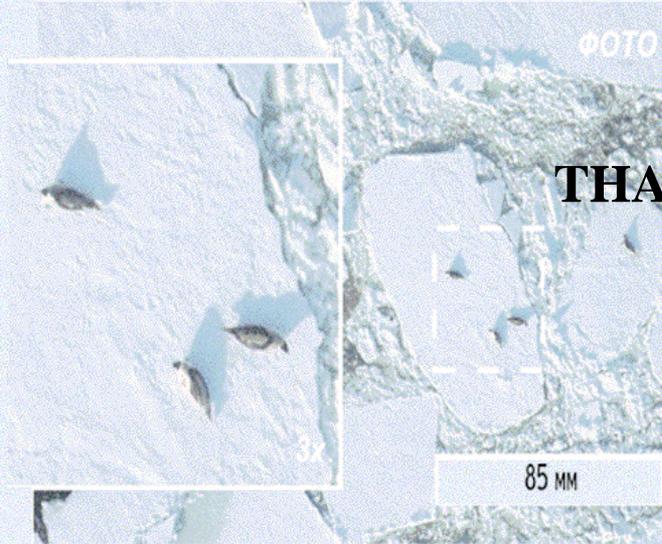
WALRUS INSIDE OF THE WHITE SEA “GORLO” (IN ENGLISH THROAT) SOUTH PART

PAPER PRINCIPALES CONCLUSIONS

1. *Aerial researches of the White Sea/Barents Sea harp seal population pup production numbers in 2010 was carried out in strong accordance with standard traditional technology and methods including ice conditions monitoring researches and studies by search of correlation between ice situation and whelping patches distribution. On base it with high probability degree one can make conclusion that during this researched works all main harp seal whelping patches were recorded, and all they placed in the White Sea area practically, ice carrying out from here was slight;*
2. *On base information presented in previous section with high probability degree one can make conclusion that whelping patches multispectral aerial surveys in 2010 with into account of pupping period in optimum time were carried out, and pup production shortage was the most minimum;*
3. *The most density harp seal whelping patches in local section of "Gorlo" the White Sea south-eastern part on boarder with Dvinsky Gulf were located. Middle, less than middle and low (rare) on density harp seal whelping patches further in periphery of the most density harp seal whelping patches were located consecutively one after another. In total all above whelping patches greater part of "Gorlo" and "Basin" the White Sea are occupied. Harp seal pup production closely coastal zone of Kola Peninsula was not recorded. Separate rare and very low on density harp seal⁵whelping patches sections in Mezensky Gulf northern-eastern part were observed. In other sections of the White Sea area pups and adult animals was not observed. Besides, single pups in Cheshskaya Bay north-western part were recorded. Pups and adults animals eastwards of this place in the Barents Sea south-eastern part adjacent area to the White Sea was not met;*
4. *In difference of previous harp seal pup production aerial researches results in 2010 walruses in "Gorlo" the White Sea was not recorded, they observed in Cheshskaya Bay area only closely of harp seal whelping patches. Nevertheless at present walrus preying on harp seal pups not need excluded including the White Sea area that was in previous years observed.*

CONTINUATION OF PAPER PRINCIPALES CONCLUSIONS

- 5. In the White Sea/Barents Sea harp seal population pup production multispectral aerial surveys carrying out in 2010 with supporting of NHMC information providing of Ice Operation Headquarters on vessels and ice breakers transportation in the White Sea area during whelping period was successfully continued. It allows exclude one of possible several negative factors which can influence to harp seal pup production status. This fact can influence to number of pups animals causing their death under biological peculiarities this life period;*
- 6. Calculations of total the White Sea/Barents Seas harp seal population pup production number which were made on base of data collected in carrying out of multispectral aerial surveys in 2010 allowed to get it value as 163 032 (SE=32 342). It some more in comparison with results of previous harp seal pup production aerial researches carried out in 2009 and top the results of pup production calculation in 2005 by 33%. As it is known this year recent historical minimum of harp seal pup production was got. Nevertheless it new value is almost less in two times in comparison with recent historical maximum still which was recorded in 2000-2003. However beginning from 2005 to current time one can note that every year the White Sea/Barents Sea harp seal pup production number has stable tendency to increase. This circumstance probably in the first is stipulated by favourable and more safe ice conditions for animals whelping.*



THANK YOU VERY MUCH FOR YOUR ATTENTION!

