Annex 18

THE FOURTH REGIONAL WORKSHOP ON SHARED STOCKS:
RESEARCH AND MANAGEMENT
IN THE SOUTH CHINA SEA

Kuala Terengganu, Malaysia 24th - 26th January 2000

APPLICATION OF REMOTE SENSING IN FISHERIES

By:

KU KASSIM KU YAACOB

MFRDMD, SEAFDEC
21080 Kuala Terengganu, Malaysia
kkasimseafdec@po.jaring.my

APPLICATION OF REMOTE SENSING IN FISHERIES

Ku Kassim Ku Yaacob
MFRDMD, SEAFDEC
21080 Kuala Terengganu, MALAYSIA
kkasimseafdec@po.jaring.my

Abstract

The remote sensing techniques is used to study the distribution of fish in relation with the oceanic phenomena such as sea surface temperature (SST) and ocean color (phytoplankton). The pelagic fishing data were analysed from May 1997 to August 1998. The satellite data from NOAA AVHRR (SST) and SeaWiFS (phytoplankton) were also analysed. The results show that a lot of pelagic fish were caught in the warm water fronts as well as in the area of high density of phytoplankton. Further analyses should be made to come out with the firmer conclusion.

INTRODUCTION

With the development of the use of electromagnetic radiation (EMR) in studying of the earth, the remote sensing technology now becoming more essential. Remote sensing is defined as the acquisition of information about an object or event on the basis of measurements taken at some distance from it. The term is normally used to describe the collection and analysis of data made by instruments carried in or above the earth's atmosphere (Butler *et al.*, 1988). Since the EMR is distributed in a scale from γ-ray (0.1 nm) to radio wave (meters, kilometers) which is used by large scale of applications from quality control in laboratory to telecommunications, it can be applied to study of the earth surface. When someone talks about remote sensing, generally this means the visible band of the sepctrum to the infrared. These are the mostly used spectrum for remote sensing.

Until recently oceanographic observations were obtained by using vessels but this method was inaccurate, as the data obtained is not real time and when the data is processed the environment has already changed. This is true as the environment around us changes very rapidly and each observation point has very different rates of change. Remote Sensing using satellites has solved this problem for us. Satellites have been able to provide us with spatial observation as the acquisition of data from areas are at the same time with the time they are processed. More over oceanographic observation needs periodical data of sea surface temperature, salinity, current conditions etc. to solve the effects of sea conditions on biological production. Fish detection also depends on the relationship between fishery information and sea surface temperature.

One of the most obvious applications is the detection of pelagic fishes such as tuna and anchovy but this is the most difficult task to achieve. The use of satellite for direct detection has not been explored enough to fully understand its potential. Although this is not always feasible satellites are used for indirect detection.

Besides resource detection remote sensing can also be valuable in characterising the marine and coastal environment. This may involve such activities as revising navigatioal charts with coastal and bathymetric data, identifying marine plants and sediment types and monitoring conditions of coastal reefs. Another important use of remote sensing is weather forecasting which could mean greater safety for fishermen. Pollution could also be monitored to avoid dissenting effects on fishing ground. With satellite data we may observe the sea surface phenomena associated with species distribution in real-time. This may simply involve projecting the distribution of fishing activities at a certain area. Satellite images could be used to describe different colours of the ocean to determine areas with huge amounts of planktons.

HOW REMOTE SENSING CAN BE USEFUL FOR FISHERY RESOURCES MANAGEMENT?

In order to manage the fisheries resources through remote sensing, we have to get correlation between oceanic phenomena with pelagic fish distribution. The seasonal current movement pattern should be understood, since the fish migrates following the current movement.

The optical remote sensing technology can be useful for pelagic fishing sector. The demersal fisheries may also use this technology, but the potential is limited. Limitation is only due to the ability of the EMR radiation. In clear water the blue light (short wavelength) can penetrate up to 60m of water depth. The penetration rate is lesser when the longer the wavelength (i.e. red and green light, as well as infrared).

The remote sensing technology is very useful to fisheries since the optical system of the technology is able to detect two most prominent oceanic phenomena, i.e. sea surface temperature and ocean color. The sea surface temperature from satellite view is also called 'skin temperature', that is the temperature of the few millimeters of ocean surface. SST is useful in studying the upwelling, fronts, as well as current. The current satellite system detects SST through the infrared region of the electromagnetic spectrum. To date there are a few satellites that are able to detect the SST such as NOAA-12, NOAA-14, NOAA-15 and ADEOS. Meanwhile the 'ocean color' refers to mostly the concentration of chlorophyll-a in the ocean. The color is detected by an optical system in visible region of electromagnetic spectrum. Chlorophyll is the basic means to measure the productivity of the sea. Generally, the fish abundance is related with the chlorophyll-a concentration in the water. At present there are various satellites detecting the ocean color such as SeaWiFS (CZCS), MOS and ADEOS.

The distribution of fish in the sea is very related to these two oceanic phenomena. The fish species might be found in certain optimum temperature. It also might be abundance in the front area, which indicated by sea surface temperature variation. According to local Malaysian fishermen, more fish can be found in warm water area. The fish is also tends to be more abundant in 'turbid' water. 'Turbid' here means the abundance of plankton in the water.

To exploit fish resources more effectively, fishermen must catch the most fish possible while at the same time minimizing cost and optimizing the schedule of their operations. The knowledge of the fishing ground locations helps fishermen in their fishing activities.

The NOAA/AVHRR data can be used to map the distribution of sea surface temperature (SST), daily. Study that had been made in Huanghai Sea and East China Sea proven that location of Japanese pilchard (*Sardinops melanosticta*) fishing ground could be predicted at accuracy up to 91.3%. SST around the area was 15-17°C (Japan Fisheries Information Service Center (JAFIC) produces satellite aided oceanographic condition charts with NOAA

AVHRR data and sends these charts to fishing vessel at sea because it was shown that NOAA AVHRR data were applicable for fishing ground forecasting. The study was also conducted in Indian Ocean (in tropical sea) to predict the distribution of yellowfin tuna due to SST. It was concluded that yellowfin tuna fishing ground could be found at SST of 27-29 °C.

Kawamura (1986) made a preliminary study on the NOAA APT signals on-board Kagoshima Maru vessel. The oceanographic features such as sea surface temperature and current could be obtained through the system. The images showed that there were two different types of water in Terengganu waters i.e. gulf waters coming down southwards from Gulf of Thailand and offshore waters going up northwards. The presence of the gulf water implies that the fishery in Terengganu waters would be affected by the movement of gulf water because most fishes tend to migrate or move with or within a water mass. Study made by Shattri, et al. (1999) in the east coast of Peninsular Malaysia has shown a high correlation between the warm water fronts and the catch of pelagic fish.

METHODS

MFRDMD is working hardly to study the fish distribution in relation with sea surface temperature and ocean colour. Data on daily fishing operation (1992-1999) by C2 Class purse seine boat (70 GRT and above) of the east coast of Peninsular Malaysia has been collected and compiled into a database. Data extracted from the boat's logbook. The data consists of date of fishing, period (days of fishing per one trip), locations (grid), kind of fish and approximate catch weight. The location of the center of the grid is appeared in Figure 1. The C2 Class purse seiner were chosen because, firstly, it was equipped with global positioning system (GPS) where the fishermen could fix their location. Secondly, the NOAA AVHRR satellite only records the top few milimeters of ocean surface. This is an inherent limitation of the satellites measurement of sea surface temperature.

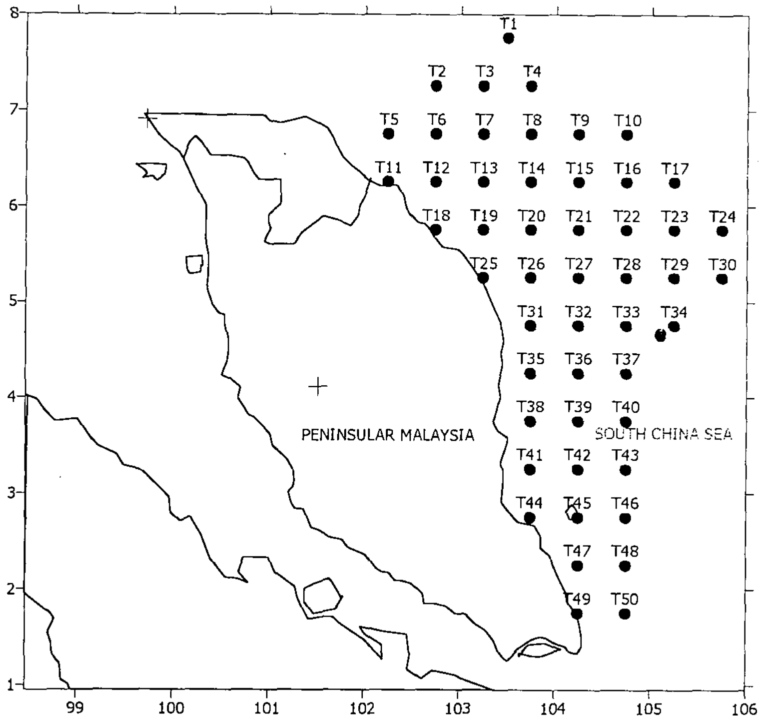


Figure 1 : Location of the center of the grid.

The fishing data then transferred into GIS (geographical information system) format and fishing location for weekly, monthly and seasonally would be plotted. At the same time, the SST data (weekly, monthly and seasonally) would be processed to determine the correlation between SST and fishing ground.

The sea surface temperature data was taken from NOAA AVHRR that were received by MFRDMD ground station. The SST was analysed using a split windows method and a tropical model. Meanwhile the SeaWiFS ocean color data was taken from Goddard DAAC, NASA. The data indicates the chlorophyll concentration in mg/m^3.

In this report only data from May 1997 to August 1998 were analyzed. The total commercial fish catch per trip data were analyzed for monthly average, while the temperature and ocean color were based on daily data. The data during clear sky are printed in the report. The SeWiFS ocean color data available in 1998.

RESULTS AND DISCUSSION

Figures 2 to 17 shows the monthly total catch per trip of commercial species of purse seiner and the daily SST and phytoplankton distributions.

In May 1997, the maximum catch per trip is up to 20 mt only at T28 and T32. Other locations show the less fish catch. In June 1997, the maximum catch per trip is up to 20 mt at T8 and T21. In July 1997, the maximum catch per trip is up to 30 mt at T10 and T15. In August 1997, the maximum catch per trip is up to 35 MT at T22, T23, T24 and T25. In September 1997, the maximum catch per trip is up to 100 mt at T22, T23, T24, T29 and T34. In October 1997, the maximum catch per trip is up to 150 mt at T37 and T40. In December 1997, the maximum catch per trip is up to 20 mt at T8, T9, T19 and T29. In January 1998, the maximum catch per trip is up to 25 mt at T23. In February 1998, the maximum catch per trip is up to 40 mt at T20. In March 1998, the maximum catch per trip is up to 15 mt at T27. In April 1998, the maximum catch per trip is up to 25 mt at T14. In May 1998, the maximum catch per trip is up to 25 mt at T24. In January 1998, the maximum catch per trip is up to 25 mt at T23. In June 1998, the maximum catch per trip is up to 20 mt at T8 and T19. In July 1998, the maximum catch per trip is up to 20 mt at T2, T3 and T19. In August 1998, the maximum catch per trip is up to 25 mt at T2, T8 and T15.

Some of the SST images show a close relationship between SST and fish abundance (total catch). More fish are caught in the warm water fronts. Meanwhile some of the ocean color maps show the high catch in high phytoplankton pigment density areas. (please refer to the maps).

However in this report, we still cannot make any conclusion of the relationship unless we reanalyze the satellite data as well as the fishing data to get the daily or weekly or monthly averages, then we can come into conclusion.

Acknowledgement

The author would like to thank Mr Mohd Nasir Muhammad Kasni for satellite data analysis. The SeaWiFS ocean color data were provided by Data Active Archive Center of Goddard Space Flight Center (DAAC, GSFC) of NASA.

References

Butler, M.J.A., Mouchot, M.C., Barale, V. and LeBlanc, C. (1988). The application of remote sensing technology to marine fisheries : An introductory manual. *FAO Fish. Tech. Paper 295.* Food and Agriculture Organisation of the United Nations. Rome.

Kawamura, G. 1986. A preliminary survey of the sea surface in Malaysian waters and the Gulf of Thailand with the aid of a satellite data utilization system. In : Mohsin, A.K.M., Mohamed, M.I. and Ambak, M.A. (eds.). *Ekspedisi Matahari '85. A study on the offshore waters of the Malaysian EEZ.* Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia. Occ. Publ. 3.

Shattri, M., Mohammed, MI and Ku-Kassim,KY (1999). Fish forecasting system. Paper presented at Geomatics Beyond 2000.: An International Conference on Geomatics for Natural Resource Assessment, Monitoring and Management, 9-11 March 1999, Dehdarun, India.

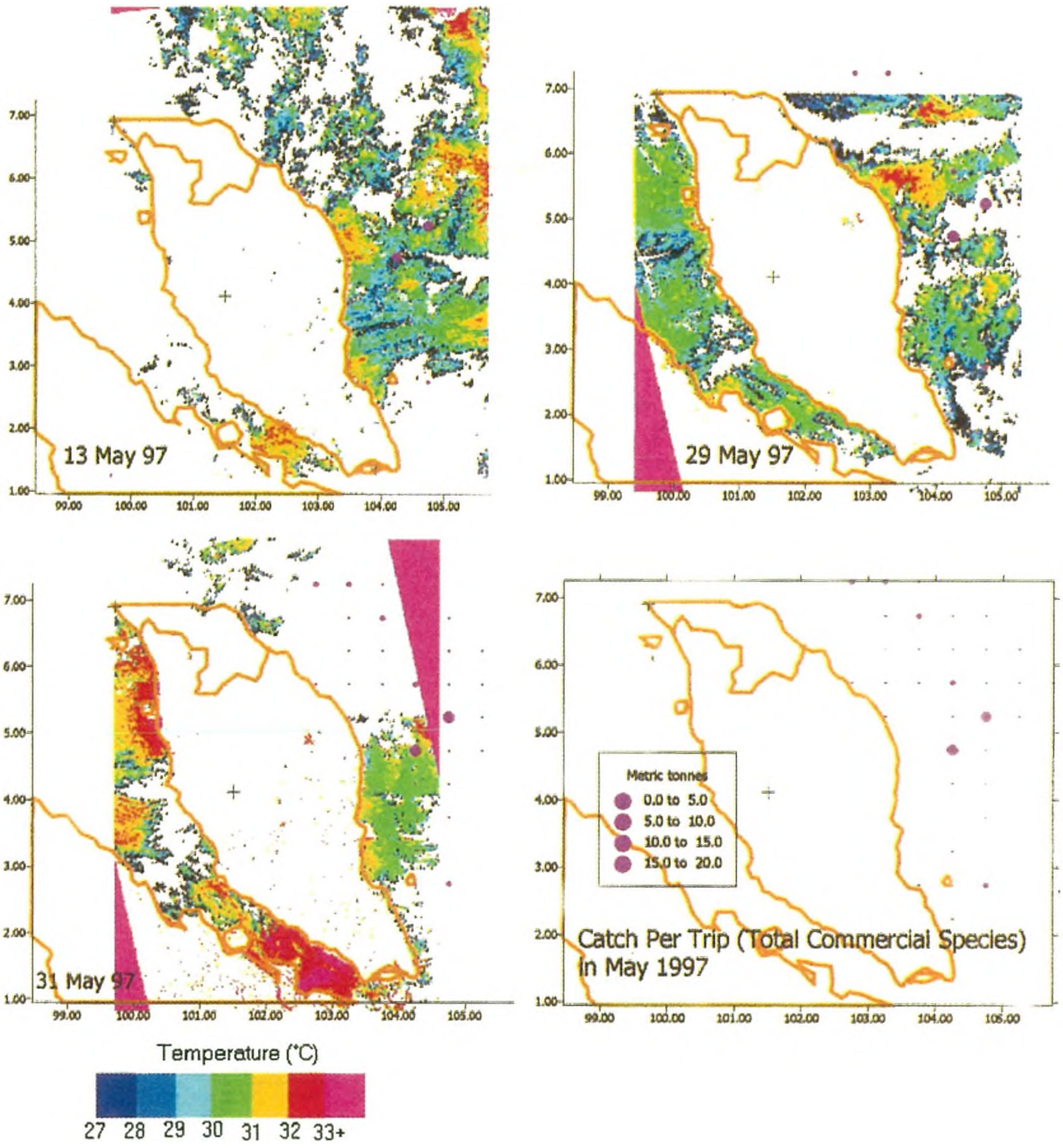

13 May 97
29 May 97
31 May 97
Metric tonnes
0.0 to 5.0
5.0 to 10.0
10.0 to 15.0
15.0 to 20.0
Catch Per Trip (Total Commercial Species)
in May 1997
Temperature (°C)
27 28 29 30 31 32 33+

Figure 2

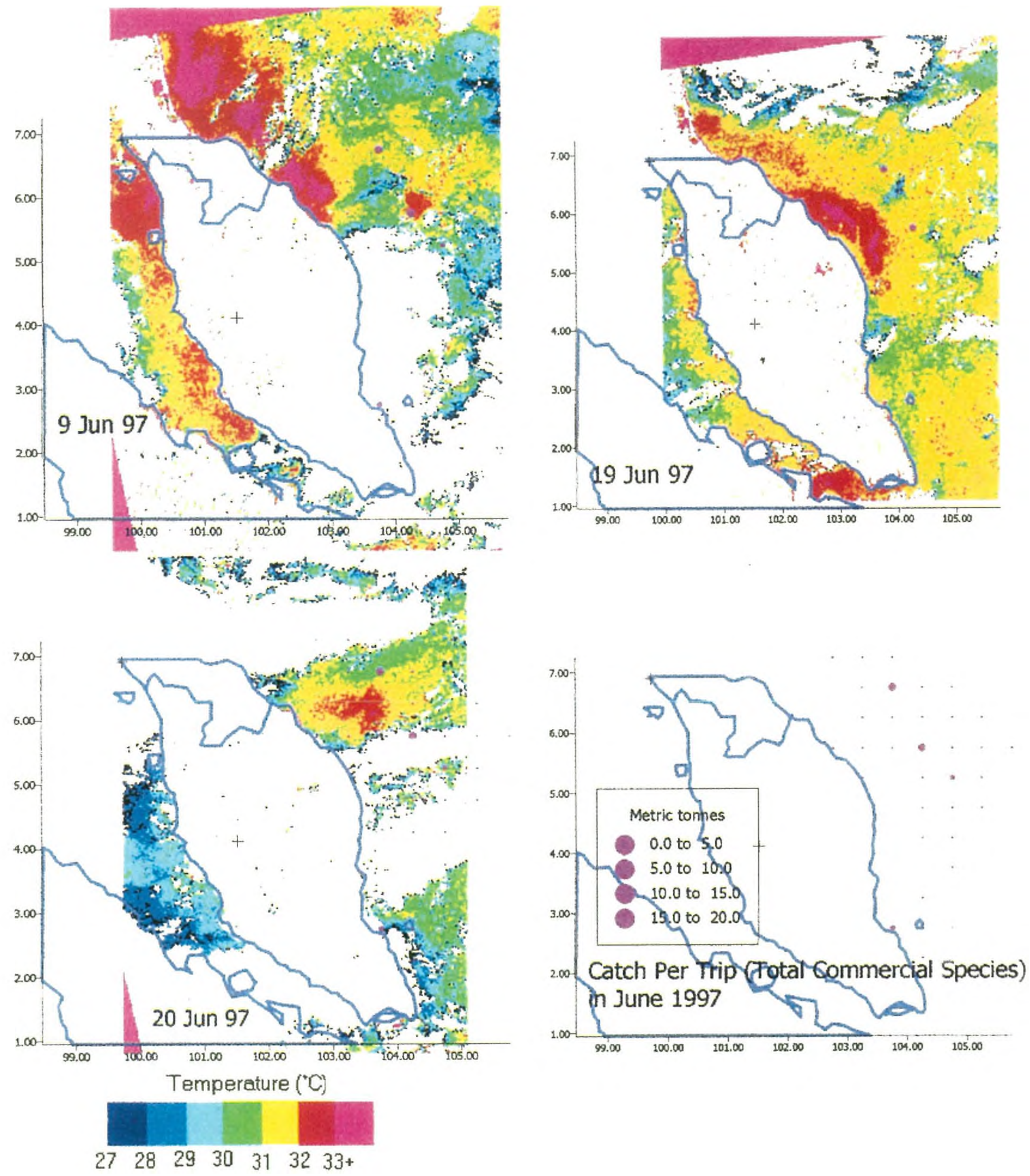

9 Jun 97
19 Jun 97
20 Jun 97
Metric tonnes
0.0 to 5.0
5.0 to 10.0
10.0 to 15.0
15.0 to 20.0
Catch Per Trip (Total Commercial Species)
in June 1997
Temperature (°C)
27 28 29 30 31 32 33+

Figure 3

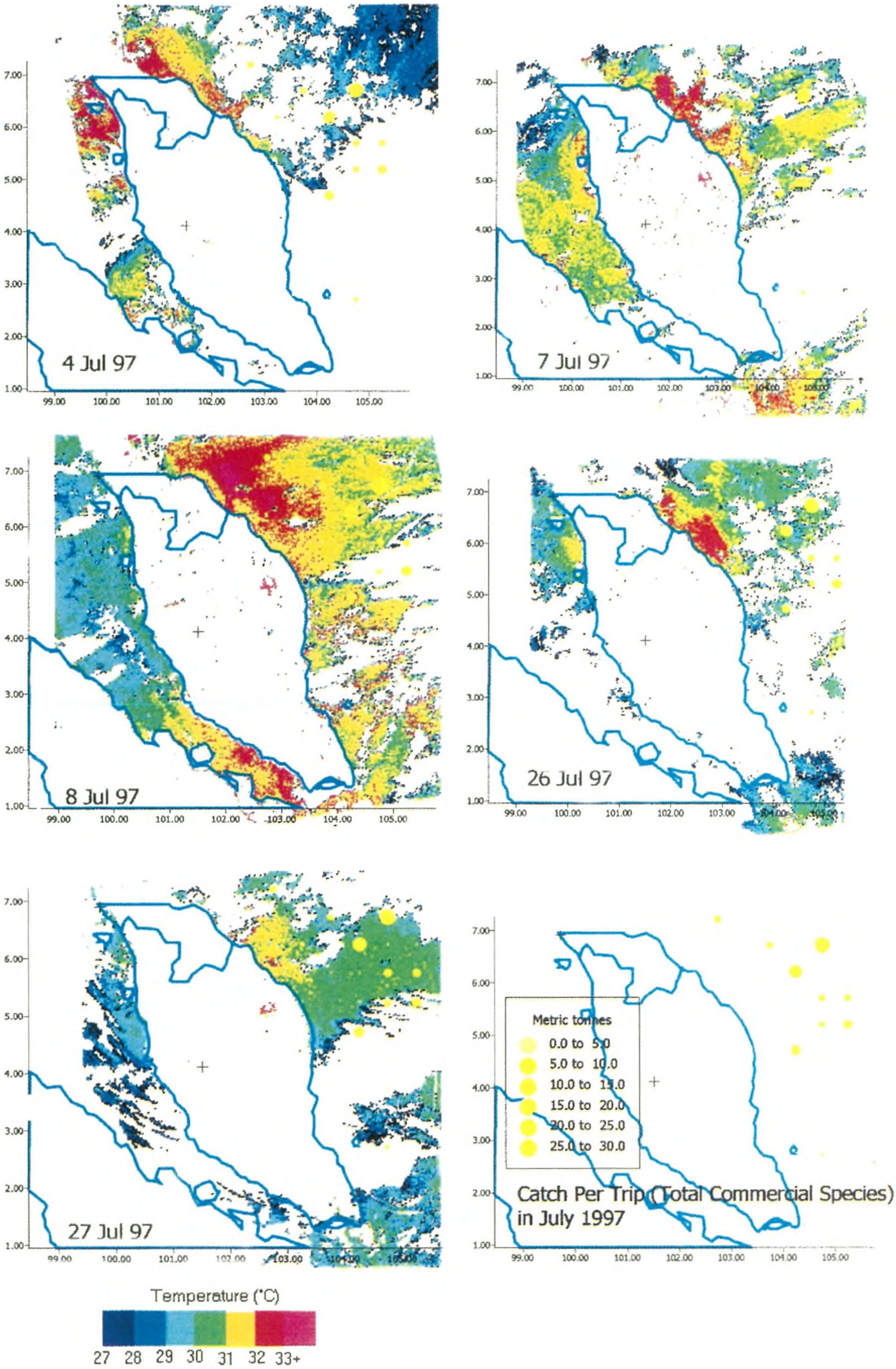

4 Jul 97
7 Jul 97
8 Jul 97
26 Jul 97
27 Jul 97
Metric tonnes
0.0 to 5.0
5.0 to 10.0
10.0 to 15.0
15.0 to 20.0
20.0 to 25.0
25.0 to 30.0
Catch Per Trip (Total Commercial Species)
in July 1997
Temperature (°C)
27 28 29 30 31 32 33+

Figure 4

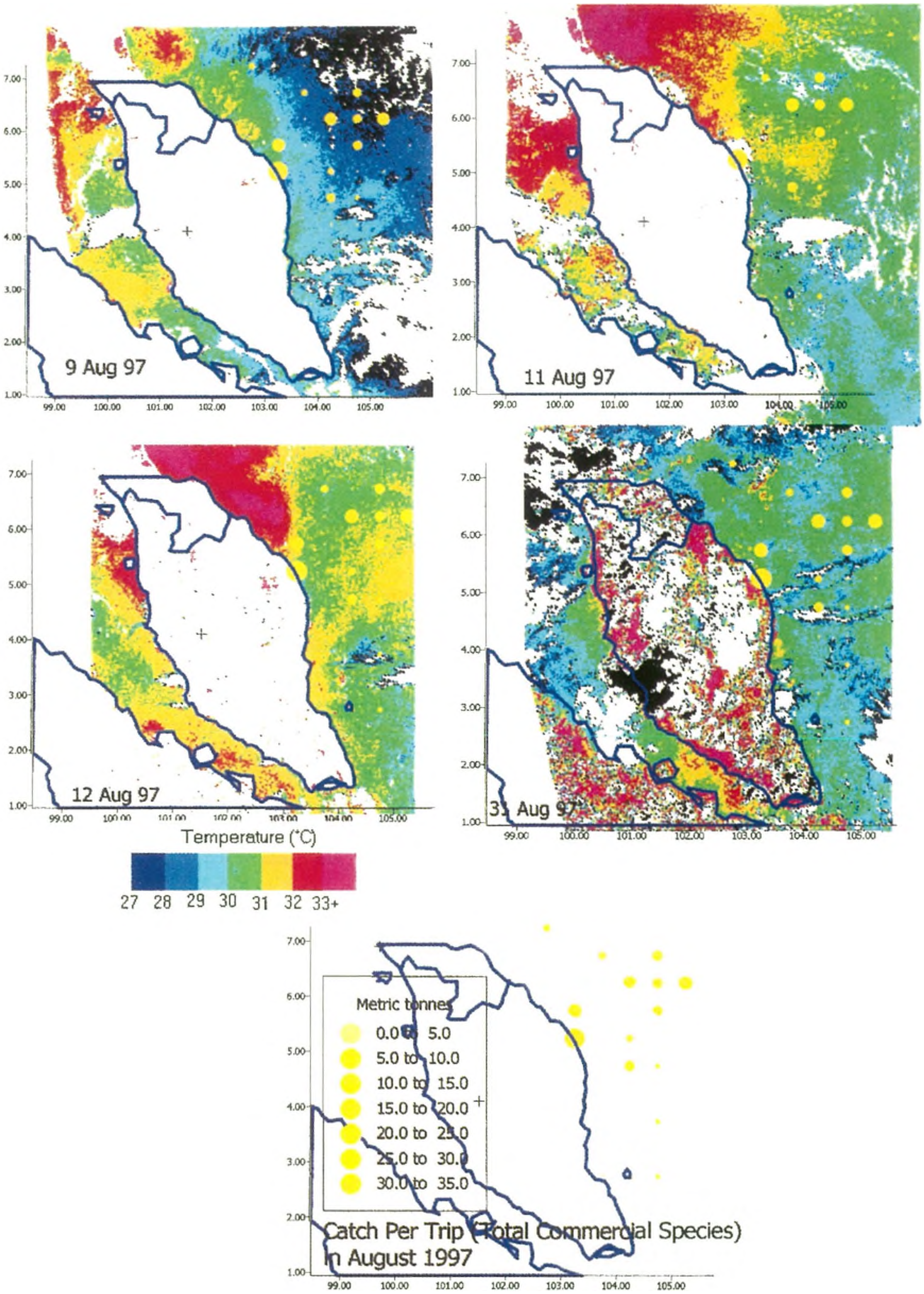

9 Aug 97
11 Aug 97
12 Aug 97
Temperature (°C)
27 28 29 30 31 32 33+
Metric tonnes
0.0 to 5.0
5.0 to 10.0
10.0 to 15.0
15.0 to 20.0
20.0 to 25.0
25.0 to 30.0
30.0 to 35.0
Catch Per Trip (Total Commercial Species)
in August 1997

Figure 5

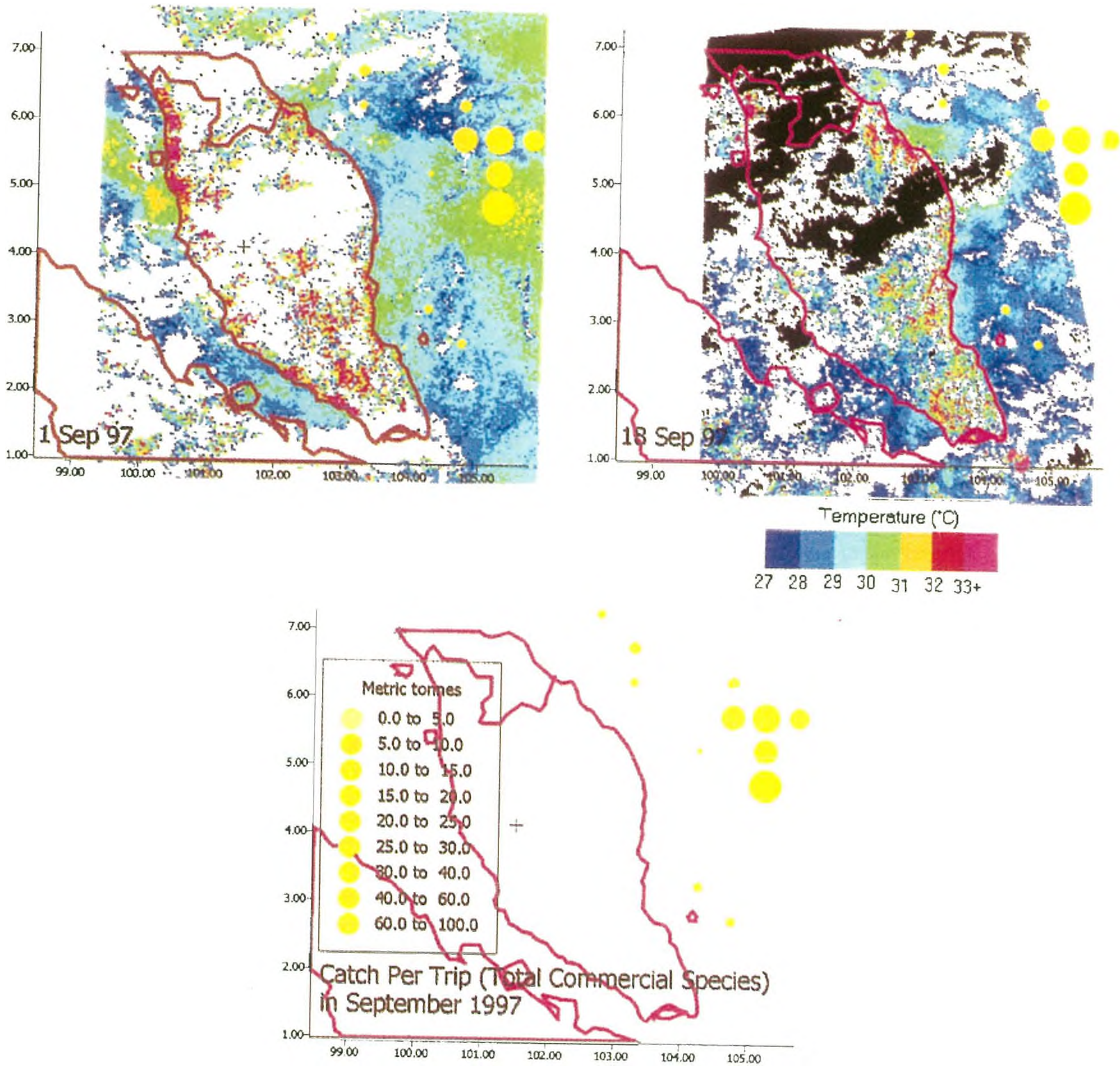

1 Sep 97
Temperature (°C)
27 28 29 30 31 32 33+
Metric tonnes
0.0 to 5.0
5.0 to 10.0
10.0 to 15.0
15.0 to 20.0
20.0 to 25.0
25.0 to 30.0
30.0 to 40.0
40.0 to 60.0
60.0 to 100.0
Catch Per Trip (Total Commercial Species)
in September 1997
7.00
6.00
5.00
4.00
3.00
2.00
1.00
99.00
100.00
101.00
102.00
103.00
104.00
105.00

Figure 6

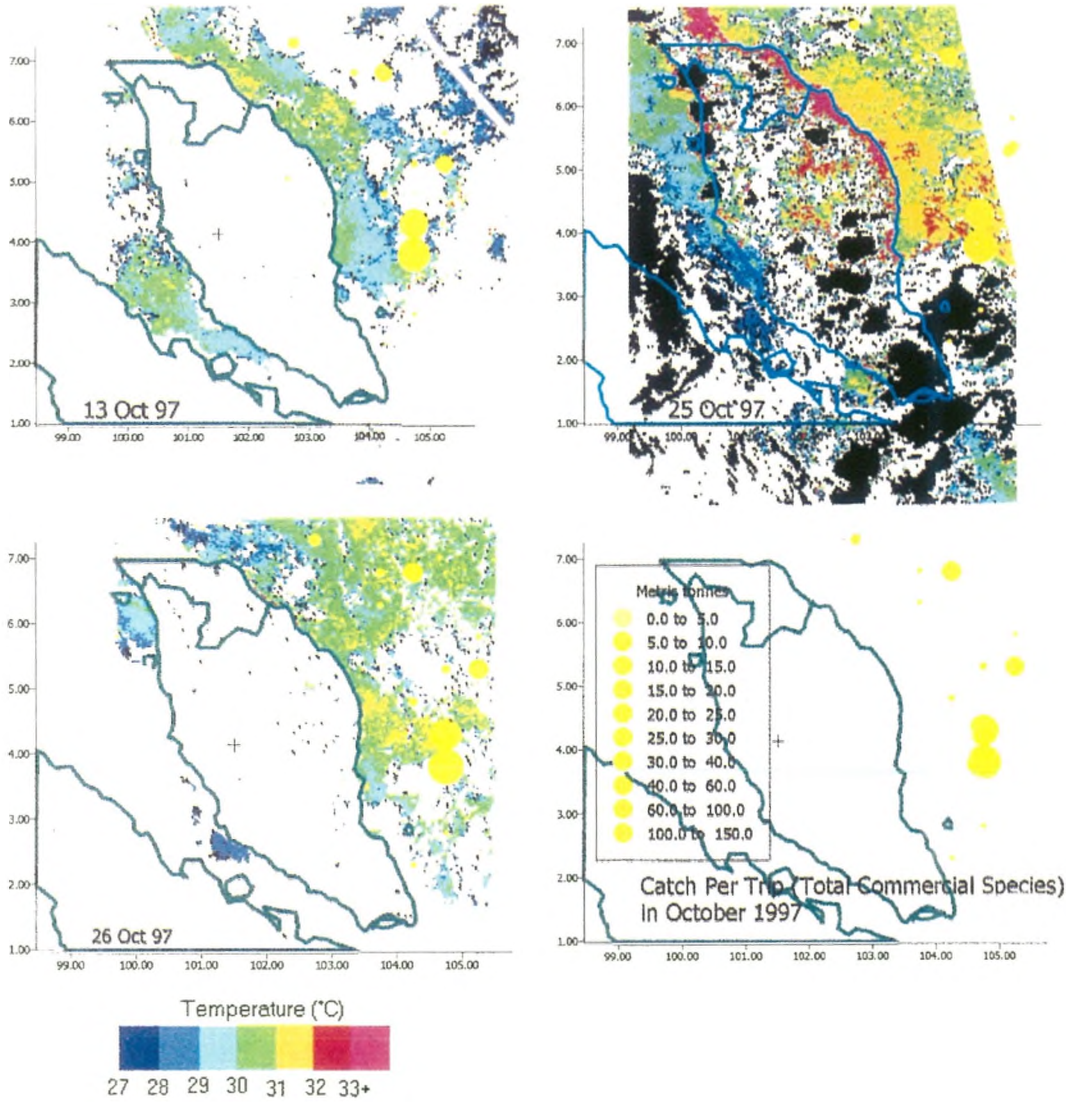

13 Oct 97
25 Oct 97
26 Oct 97
Catch Per Trip (Total Commercial Species)
in October 1997
0.0 to 5.0
5.0 to 10.0
10.0 to 15.0
15.0 to 20.0
20.0 to 25.0
25.0 to 30.0
30.0 to 40.0
40.0 to 60.0
60.0 to 100.0
100.0 to 150.0
Temperature (°C)
27 28 29 30 31 32 33+

Figure 7

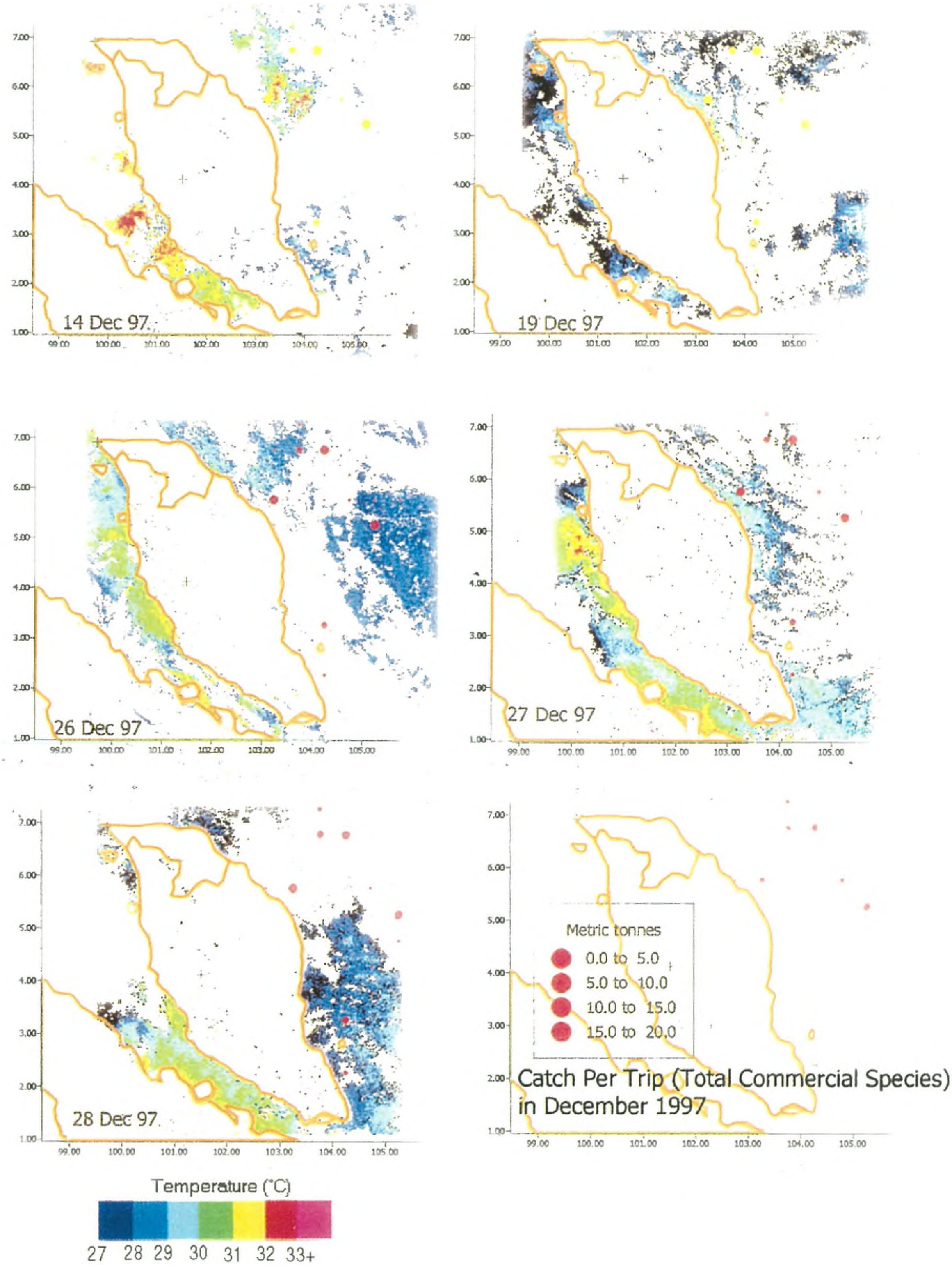
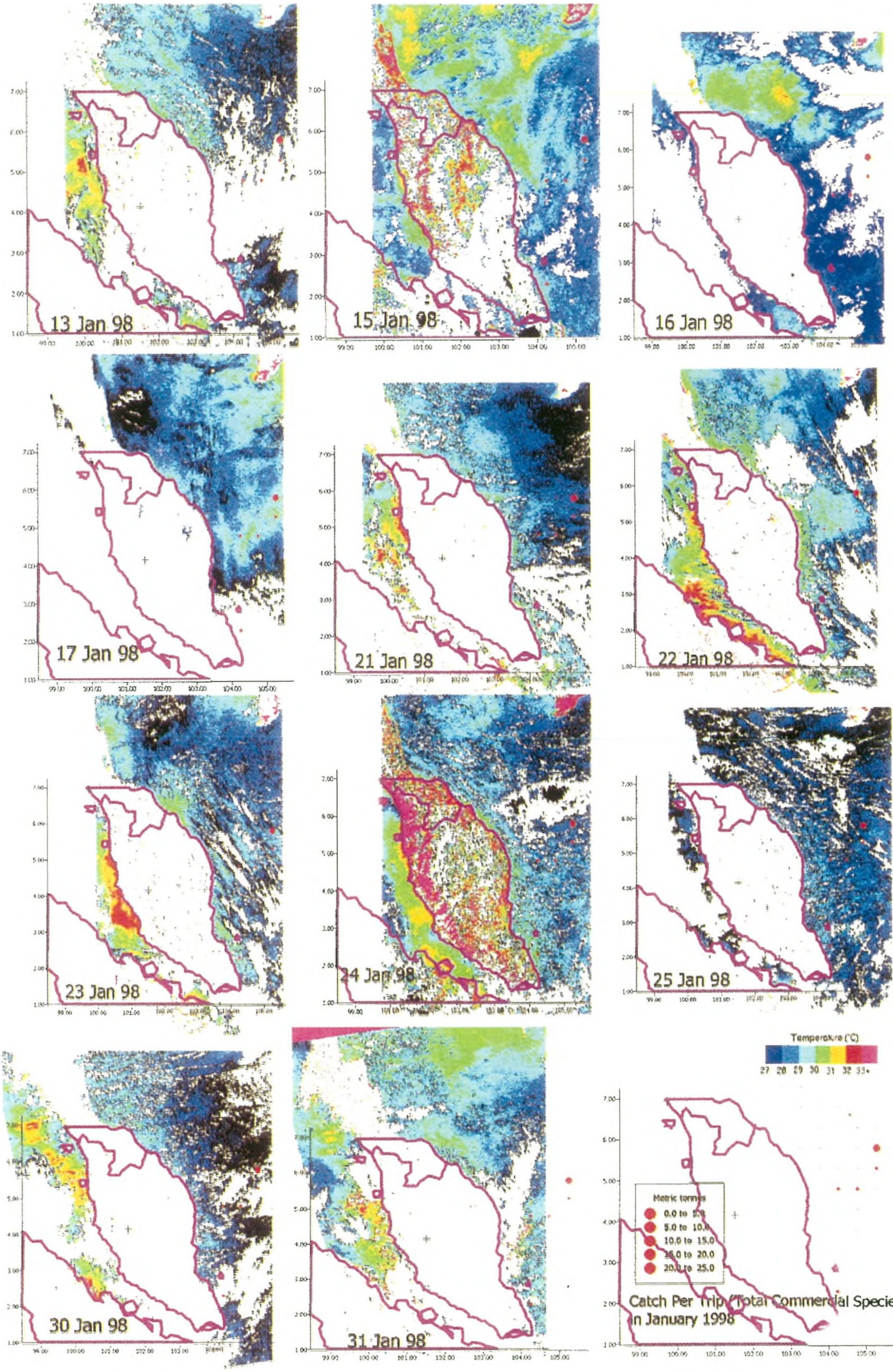

14 Dec 97
19 Dec 97
26 Dec 97
27 Dec 97
28 Dec 97
Metric tonnes
0.0 to 5.0
5.0 to 10.0
10.0 to 15.0
15.0 to 20.0
Catch Per Trip (Total Commercial Species)
in December 1997
Temperature (°C)
27 28 29 30 31 32 33+

Figure 8



13 Jan 98
15 Jan 98
16 Jan 98
17 Jan 98
21 Jan 98
22 Jan 98
23 Jan 98
24 Jan 98
25 Jan 98
30 Jan 98
31 Jan 98
Temperature (°C)
27 28 29 30 31 32 33+
Metric tonnes
10.0 to 15.0
Catch Per Trip (Total Commercial Species)
in January 1998

Figure 9

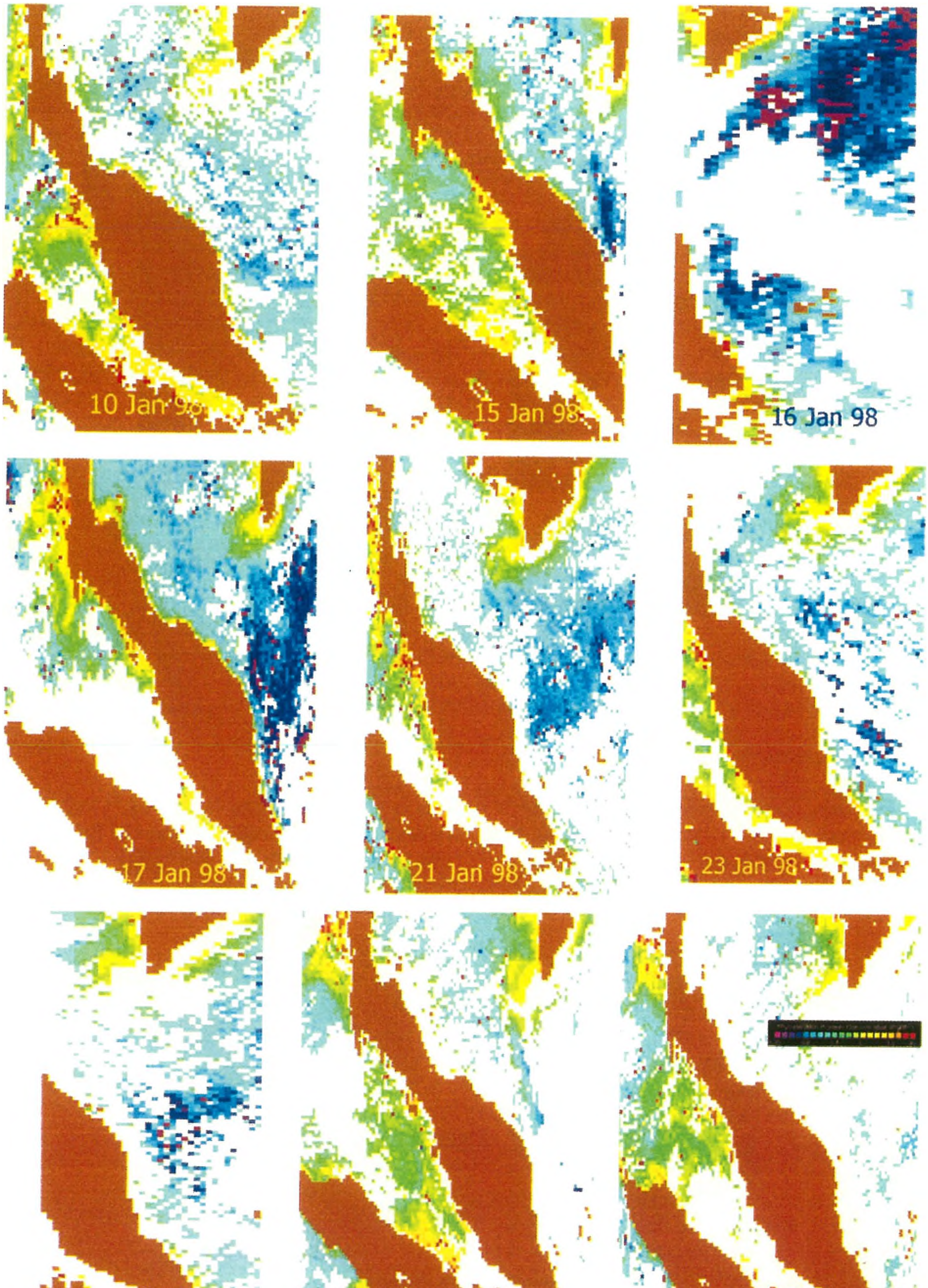
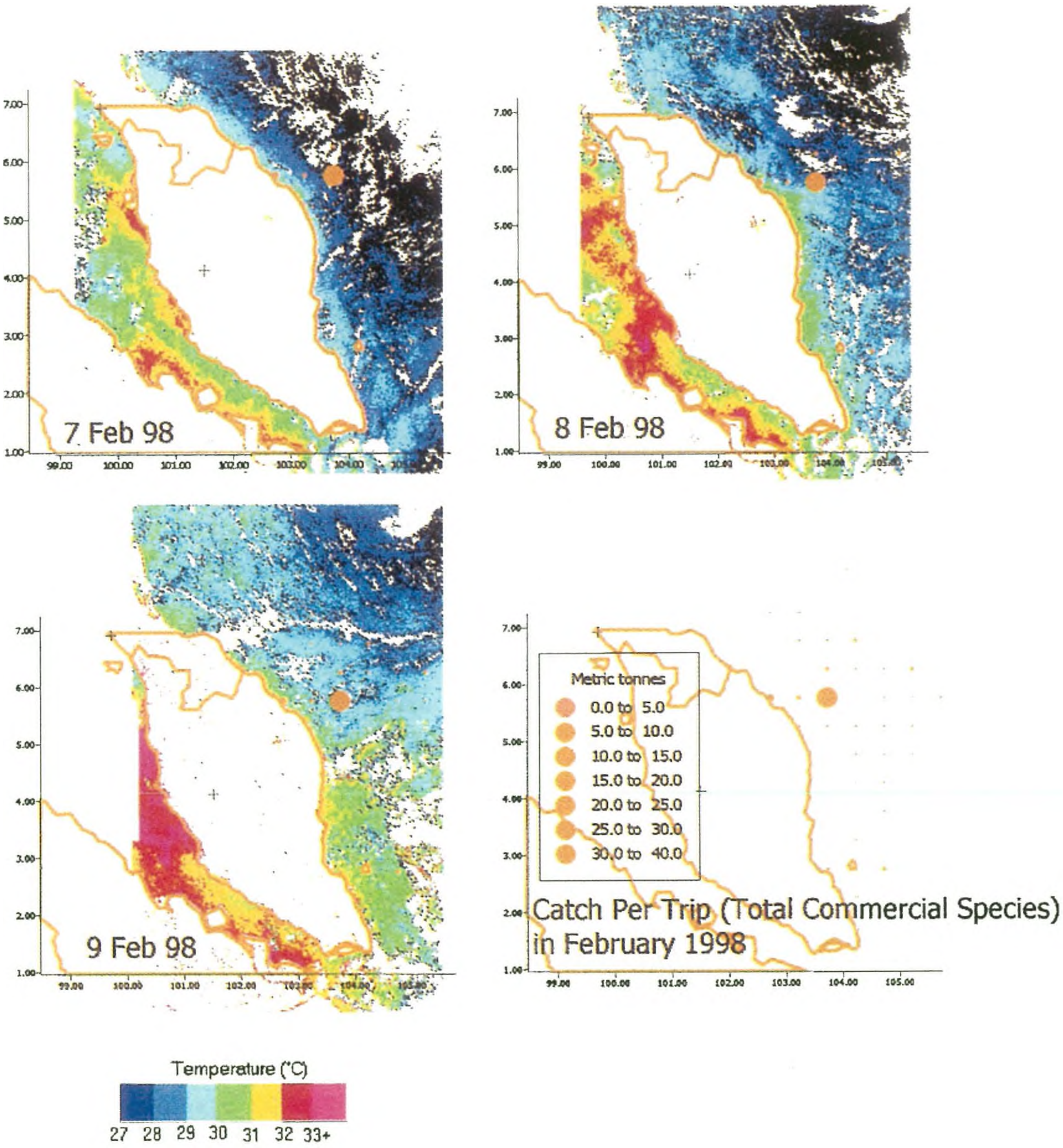

10 Jan 98
15 Jan 98
16 Jan 98
17 Jan 98
21 Jan 98
23 Jan 98
25 Jan 98
28 Jan 98
30 Jan 98

Figure 10



7 Feb 98
8 Feb 98
9 Feb 98
Metric tonnes
0.0 to 5.0
5.0 to 10.0
10.0 to 15.0
15.0 to 20.0
20.0 to 25.0
25.0 to 30.0
30.0 to 40.0
Catch Per Trip (Total Commercial Species)
in February 1998
Temperature (°C)
27 28 29 30 31 32 33+

Figure 11

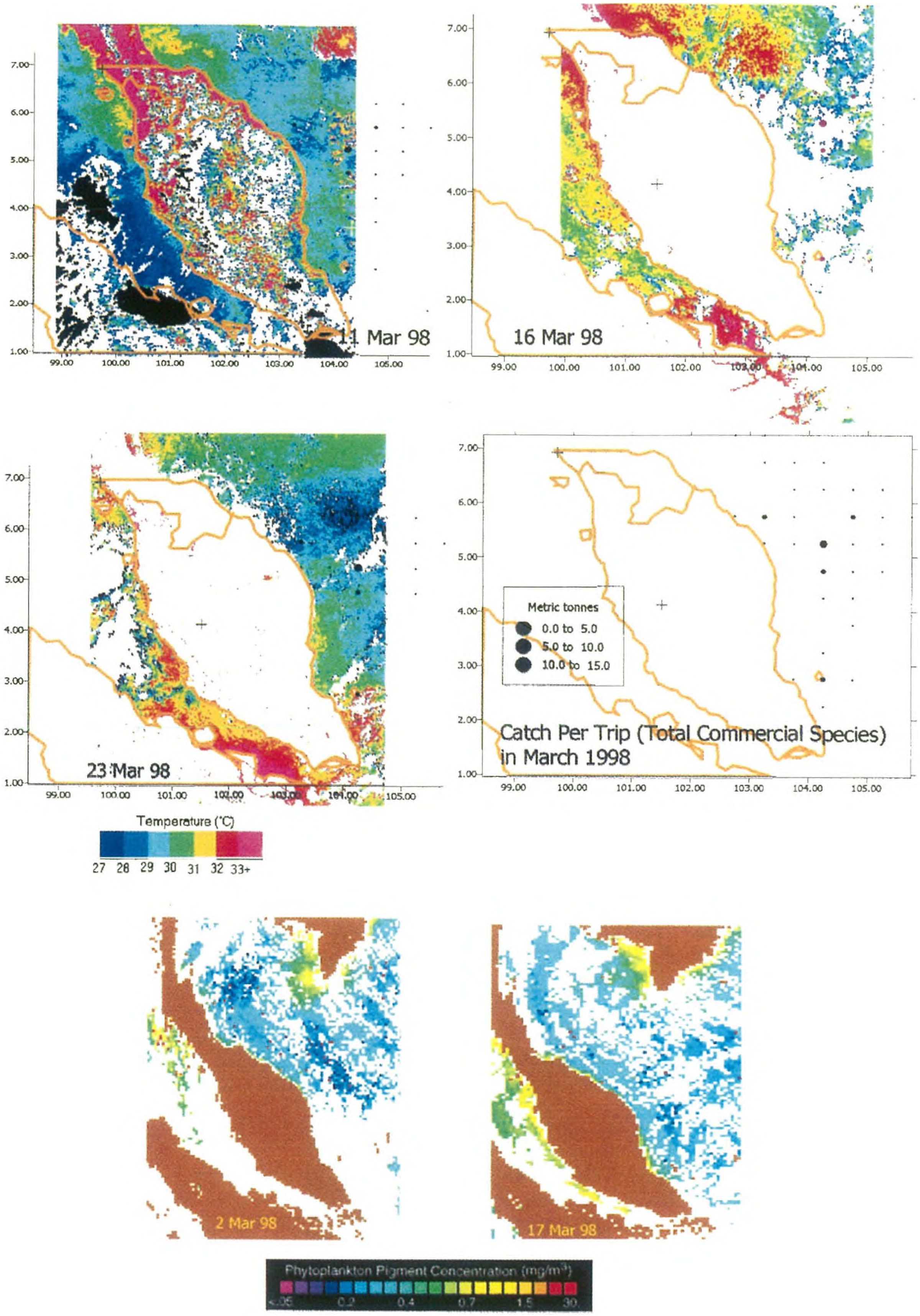

11 Mar 98
16 Mar 98
23 Mar 98
Metric tonnes
0.0 to 5.0
5.0 to 10.0
10.0 to 15.0
Catch Per Trip (Total Commercial Species) in March 1998
Temperature (°C)
27 28 29 30 31 32 33+
2 Mar 98
17 Mar 98
Phytoplankton Pigment Concentration (mg/m³)
<.05 0.2 0.4 0.7 1.5 30

Figure 12

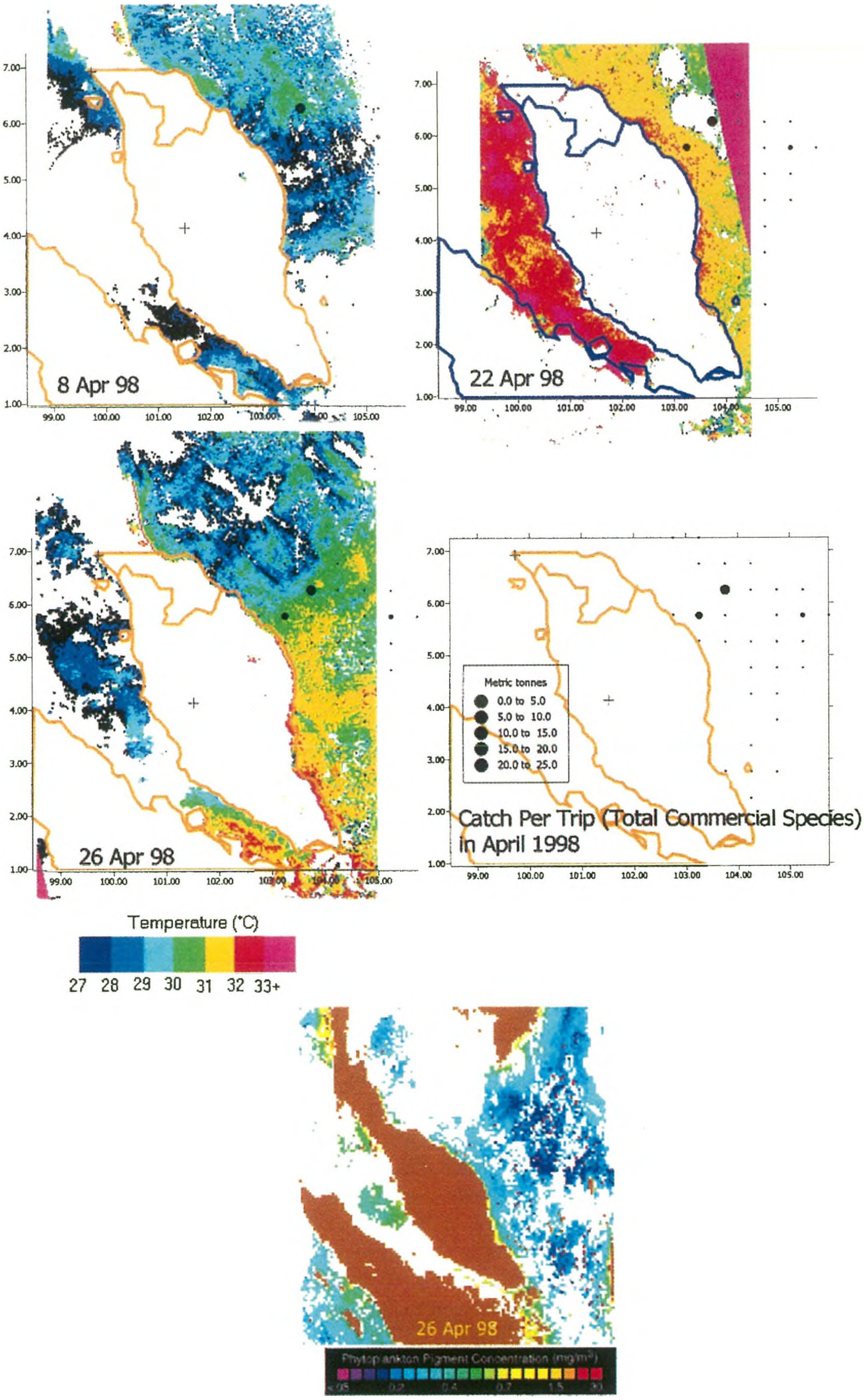
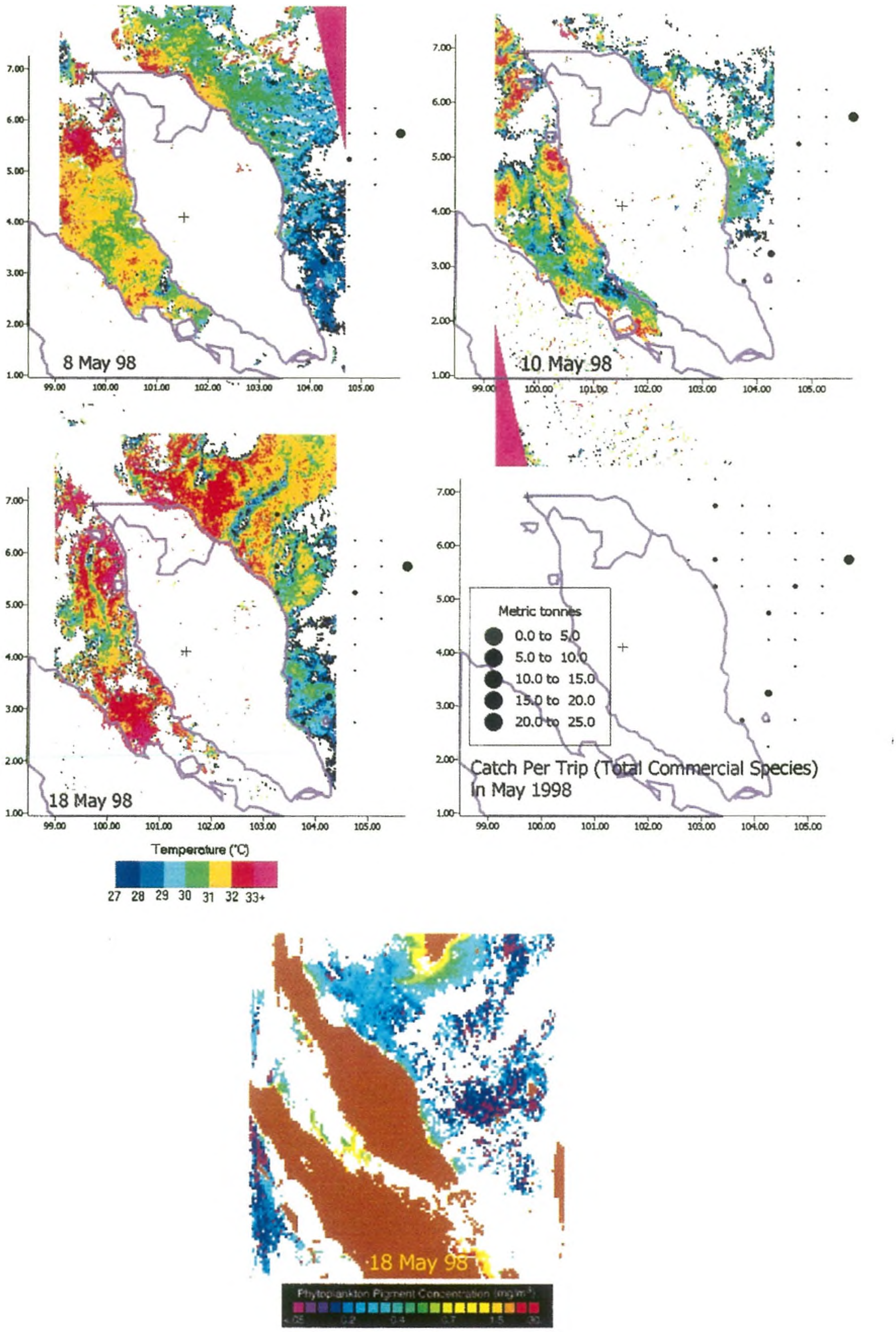

8 Apr 98
22 Apr 98
26 Apr 98
Metric tonnes
0.0 to 5.0
5.0 to 10.0
10.0 to 15.0
15.0 to 20.0
20.0 to 25.0
Catch Per Trip (Total Commercial Species)
in April 1998
Temperature (°C)
27 28 29 30 31 32 33+
26 Apr 98
Phytoplankton Pigment Concentration (mg/m³)

Figure 13



8 May 98
10 May 98
18 May 98
Metric tonnes
0.0 to 5.0
5.0 to 10.0
10.0 to 15.0
15.0 to 20.0
20.0 to 25.0
Catch Per Trip (Total Commercial Species)
in May 1998
Temperature (°C)
27 28 29 30 31 32 33+
18 May 98
Phytoplankton Pigment Concentration (mg/m³)

Figure 14

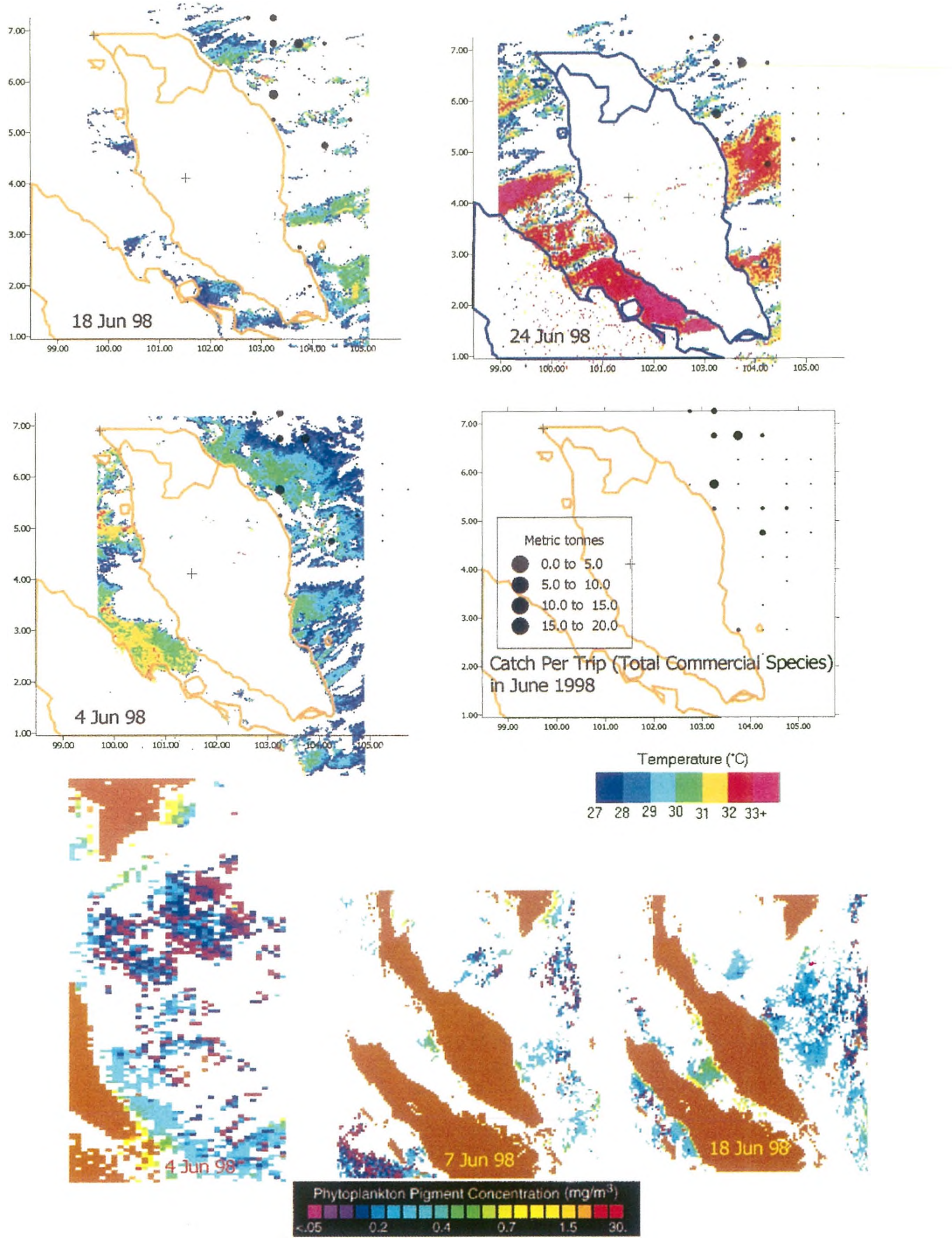
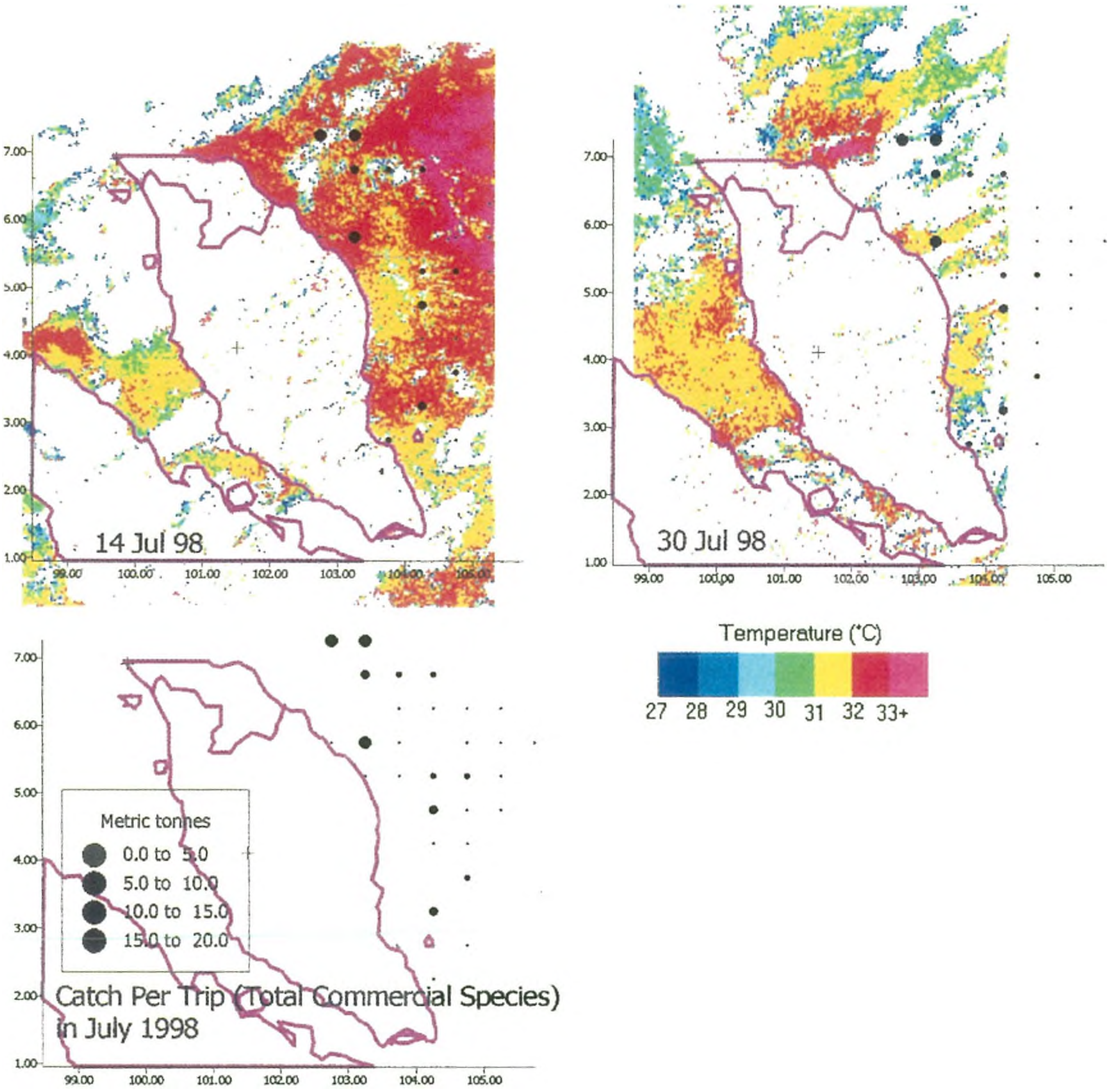
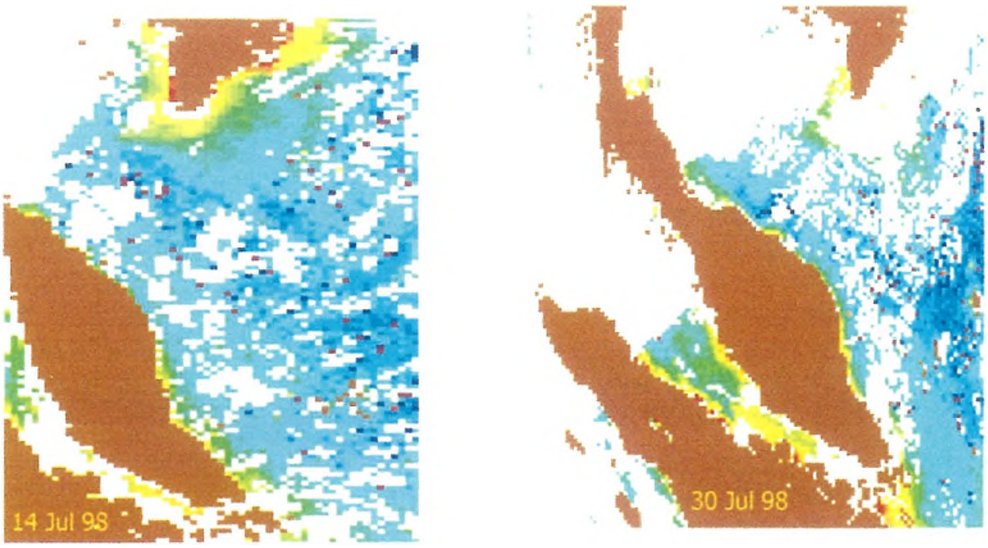

18 Jun 98
24 Jun 98
4 Jun 98
Metric tonnes
0.0 to 5.0
5.0 to 10.0
10.0 to 15.0
15.0 to 20.0
Catch Per Trip (Total Commercial Species)
in June 1998
Temperature (°C)
27 28 29 30 31 32 33+
4 Jun 98
7 Jun 98
18 Jun 98
Phytoplankton Pigment Concentration (mg/m³)
<.05 0.2 0.4 0.7 1.5 30.

Figure 15


14 Jul 98
30 Jul 98
Temperature (°C)
27 28 29 30 31 32 33+
Metric tonnes
0.0 to 5.0
5.0 to 10.0
10.0 to 15.0
15.0 to 20.0
Catch Per Trip (Total Commercial Species)
in July 1998
99.00 100.00 101.00 102.00 103.00 104.00 105.00
1.00 2.00 3.00 4.00 5.00 6.00 7.00


14 Jul 98
30 Jul 98


Phytoplankton Pigment Concentration (mg/m3)
<.05 0.2 0.4 0.7 1.5 30.

Figure 16

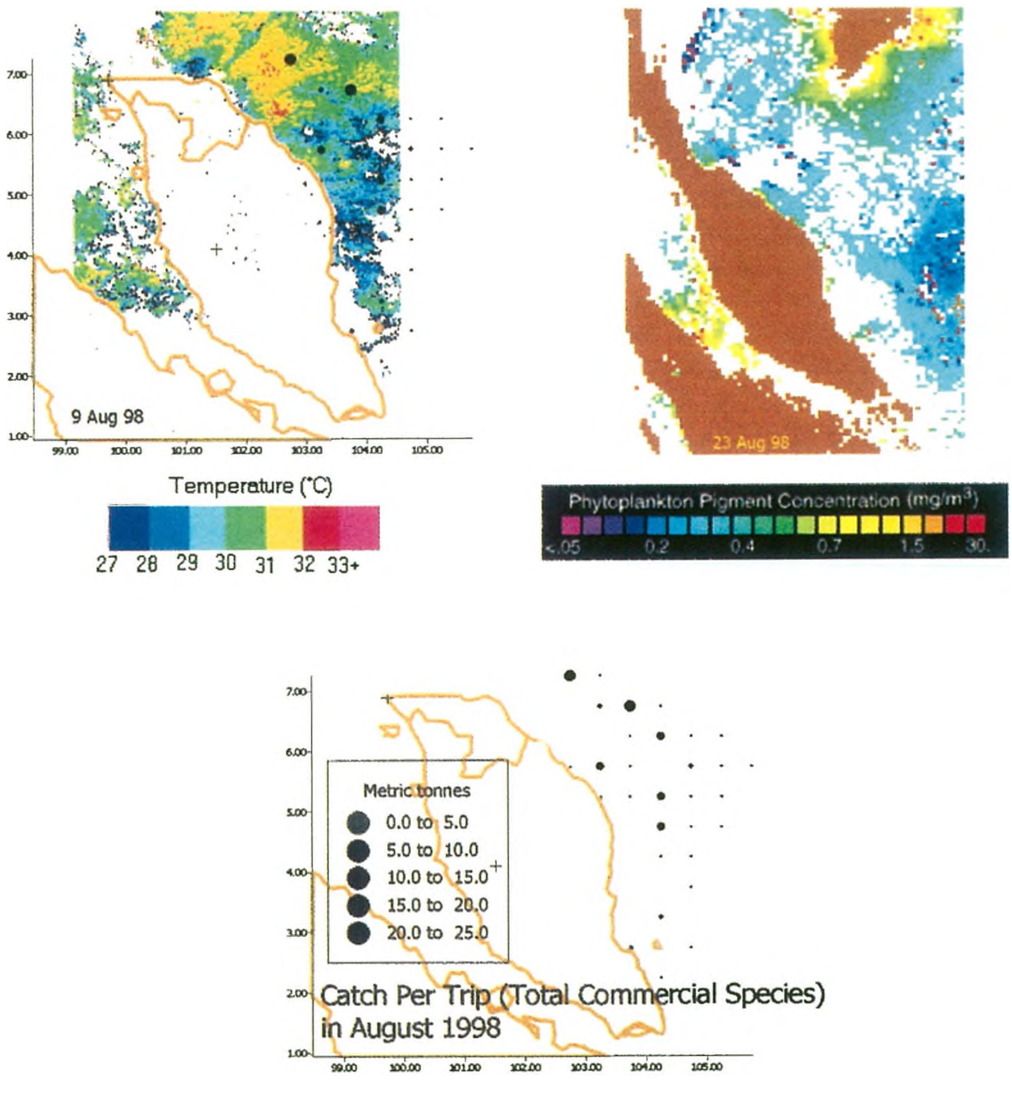

9 Aug 98
Temperature (°C)
27 28 29 30 31 32 33+
23 Aug 98
Phytoplankton Pigment Concentration (mg/m³)
<.05 0.2 0.4 0.7 1.5 30.
Metric tonnes
0.0 to 5.0
5.0 to 10.0
10.0 to 15.0
15.0 to 20.0
20.0 to 25.0
Catch Per Trip (Total Commercial Species)
in August 1998

Figure 17