STUDIES OF THE RELATION BETWEEN THE WHALING GROUNDS AND THE HYDROGRAPHIC CONDITIONS

II. A STUDY OF THE RELATION BETWEEN THE WHALING GROUNDS OFF KINKAZAN AND THE BOUNDARY OF WATER MASSES

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The whaling Grounds off Kinkazan are world-known since the active hunting by the American whaling fleets in 19 century and nowadays exploited by the Japanese whalers to the offing about 250 sea-miles from the coast. Uda (1954) has proved already the intimate relation between the distribution of whaling grounds and the sharp boundary of water masses or oceanic front. Proceeding to study the conditions in detail, we have investigated the data obtained from the offing of Kinkazan during the years from 1946 to 1954 by the Japanese whalers. The results are as follows:

1. Generally the whaling grounds were observed near the boundary zone of water masses (frontal zone) corresponding to the sharp temperature gradient of sea water.

2. The whaling grounds shift seasonally and temporarily in accompany with the movement of oceanic front.

3. Oceanic front and whaling grounds shift to north in the offing of Kinkazan in summer and come down to south in autumn.

4. Usually we can find the whaling grounds off Kinkazan within 60 seamiles in the direction between south and east from the center or core of oceanic front.

5. As already reported by Uda (1954) the boundary between the cold upwelling water mass of cyclonic eddy and the warm water mass (anticyclonic eddy), forming a cyclonic revolving pattern of the tongues of cold and warm currents corresponds to the center of the most favourable whaling grounds (See e.g. Fig. 1).

It may be due to the plenty concentration of food organisms such as euphausid, copepods, squids and fishes which assembled to the boundary of water masses by the convergence of currents.

6. Sperm whale was frequently seen on the side of cold current zone, and sei whale appeared frequently on the side of warm current zone and especially both densely observed near the tongues of cold and warm currents.

7. The whaling grounds distribute generally around the most re-

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markable oceanic front (sharp boundary) which may be denoted by the steepest horizontal gradient of water temperature (θ°C) i.e. $(\partial\theta/\partial l)_{max.}$ where l is the horizontal distance in sea-miles. First we have estimated the frequency of fronts passing through the half degree rectangle of longitude and latitude.

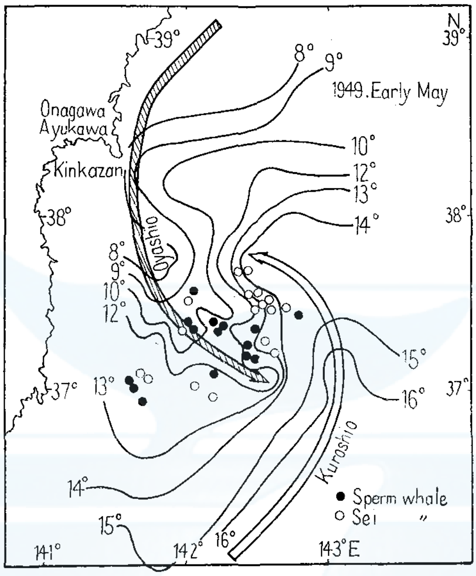


Fig. 1. Typical feature of Oceanographic Pattern of Surface Water Temperature and the Distribution of Whaling Grounds.

For our convenience we can define the 'intensity' of oceanic front

$$S=\partial\theta/\partial l$$

and the 'power' of oceanic front

$$W=\partial\theta/\partial l \times n$$

where n denotes the number of fronts passing through in that rectangle in the period during the period (1946–54) and in actual calculation

$$\partial\theta/\partial l - 0.4°C/SM \text{ adopted.}$$

and weighted number of n (taking the weight at diagonal max. length 1, and at its corner 0). (The tables neglected).

Fig. 2 shown in each decade compiled in 1946–54. The main whaling ground I (37°–38.5°N, 142°–143.5°E, May–Dec.), the second whaling ground II (38°–39.5°N, Late June–Middle Oct.) and the third ground III (38°–39.5°N, 145.5°–146°E, July–Sept.) are seen from Fig. 2. The location of oceanic fronts were almost always recognized in the north-western side of the whaling grounds.

8. Seasonal variation of whale catch.

a) Sperm whale. During summer and autumn season, the catch of sperm whale reaches its peak twice in the year (from middle July to early September and early October to late November).

b) Sei whale. During the season from late June to late August, the catch of sei whale attains to its peak.

c) Fin whale. From May to September fin whales were caught but in far few number compared to the above 2 species.

9. The movements of the centre of whaling grounds and of the core of oceanic fronts are coupled together as shown in Fig. 4.

LITERATURE

UDA, M. (1954). Studies of the relation between the whaling grounds and the hydrographic conditions (I). *Sci. Rep. Whales Res. Inst.*, no. 9: 179–187.

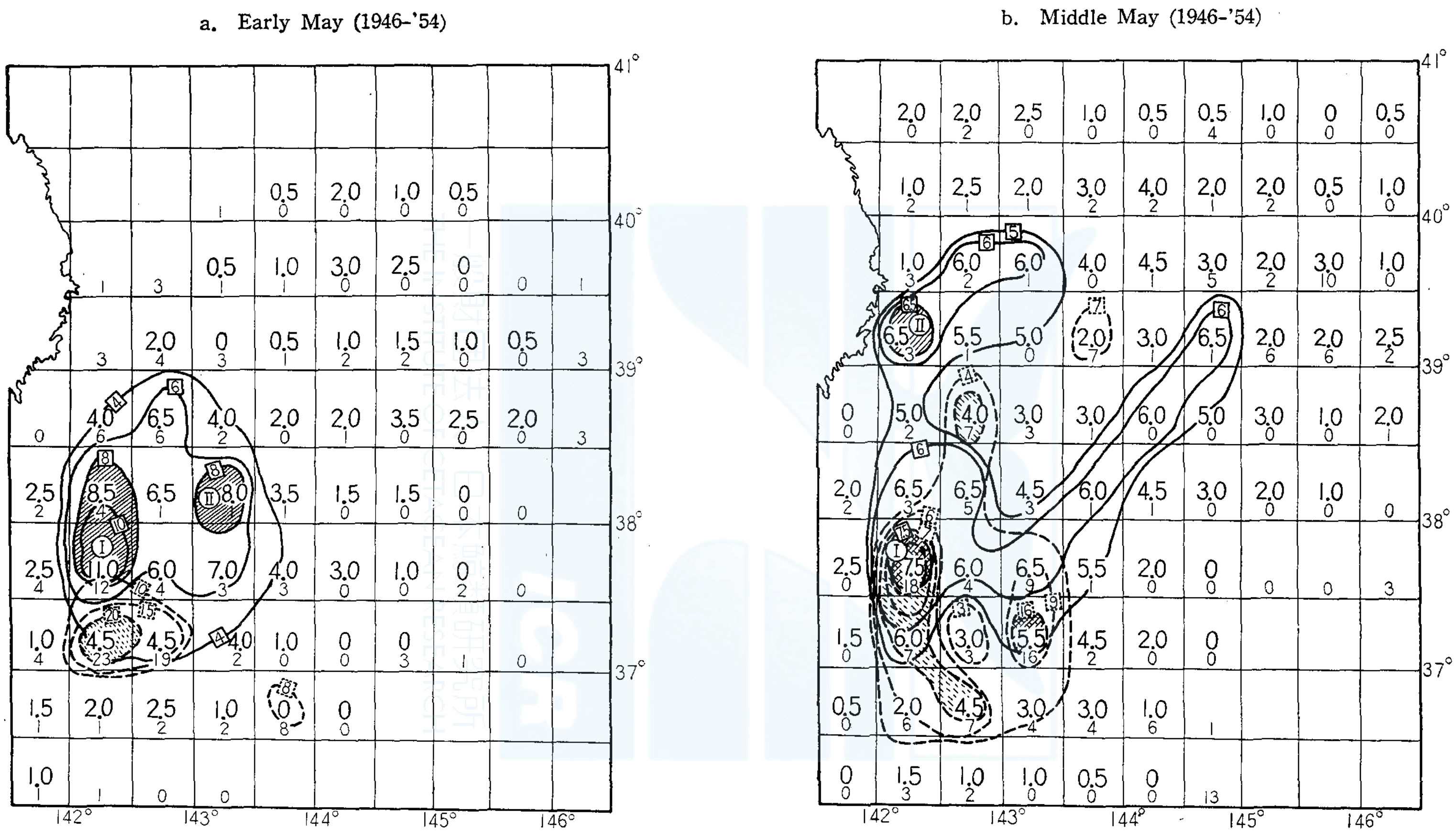


Fig. 2. Frequency Distribution of Oceanic Front (—) and Whaling Ground (- - -).

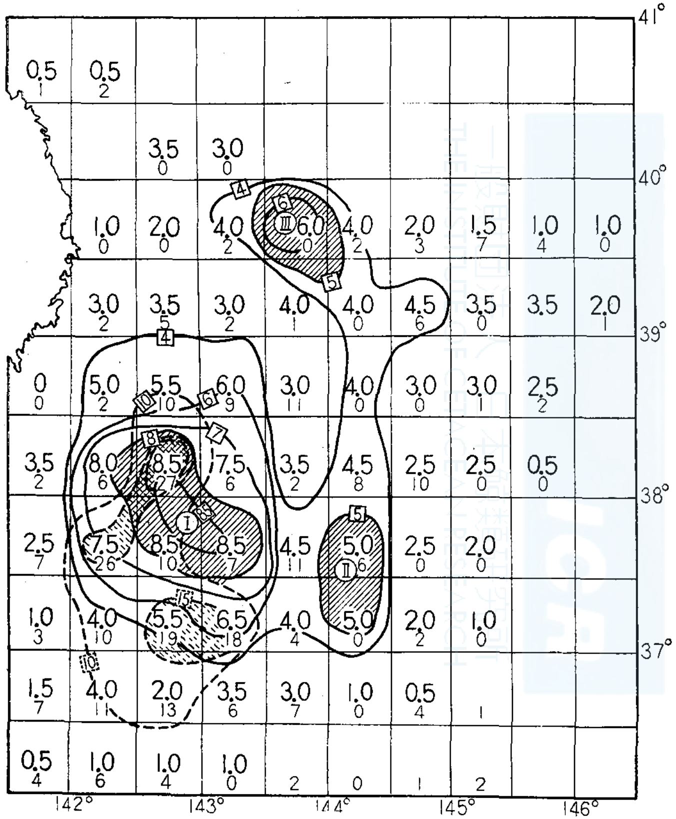
a. (I) $\partial\theta/\partial l=0.47$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.47\times 11.0=5.17$ 18∼10°C

(II) $\partial\theta/\partial l=0.48$ $W_{\mathrm{II}}=\partial\theta/\partial l\times n=0.48\times 8.0=3.84$ 16∼8

b. (I) $S=\partial\theta/\partial l=0.43$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.43\times 7.5=3.23$ max $\theta=18$ min $\theta=10$

(II) $S=\partial\theta/\partial l=0.40$ $W_{\mathrm{II}}=\partial\theta/\partial l\times n=0.40\times 6.5=2.6$ max $\theta=15$ min $\theta=6$

c. Late May (1946-'54)

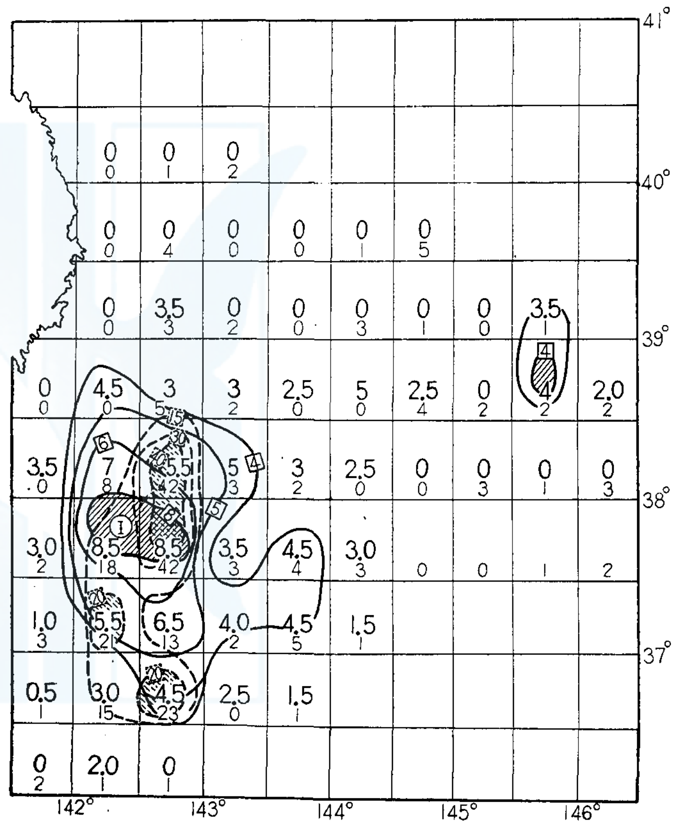


(I) $S=\partial\theta/\partial l=0.47$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.47\times 8.5=4$ max θ=20°C min θ=12°C

(II) $S=\partial\theta/\partial l=0.45$ $W_{\mathrm{II}}=\partial\theta/\partial l\times n=0.45\times 5.0=2.25$ 〃 =20°C 〃 =15°C

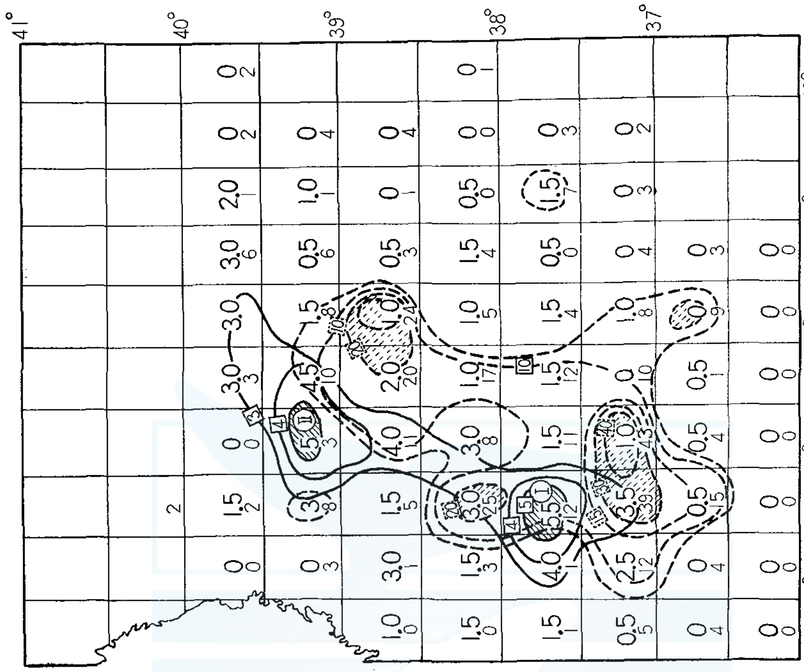
(III) $S=\partial\theta/\partial l=0.4$ $W_{\mathrm{III}}=\partial\theta/\partial l\times n=0.4\times 6.0=2.4$ 〃 =14°C 〃 =8°C

d. Early June (1946-'54)



(I) $\partial\theta/\partial l=0.5$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.5\times 8.5=4.25$ max θ=20 min θ=14

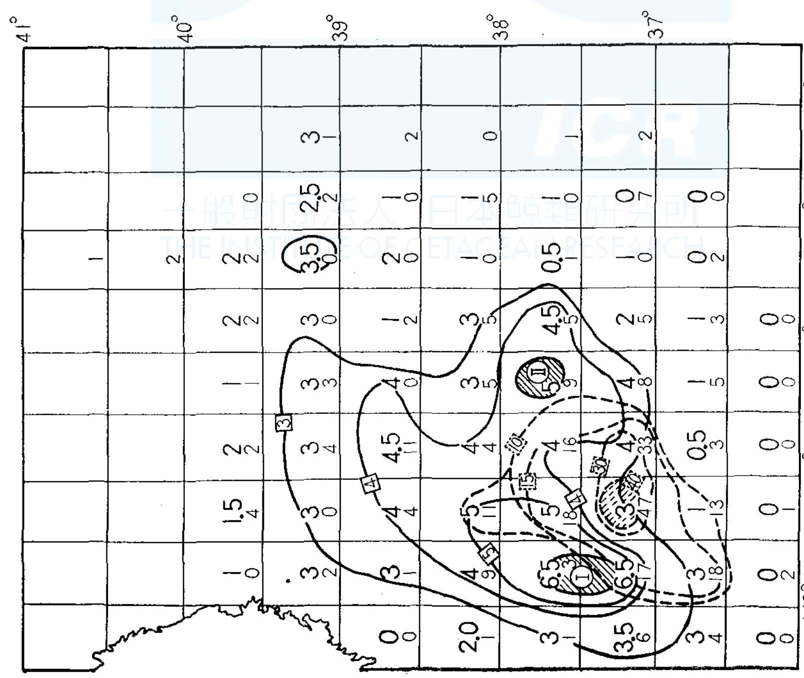
f. Late June (1946-'54)



(I) $\partial\theta/\partial l=0.53$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.53\times 5.5=2.92$ max θ~min θ 22~14

(II) $\partial\theta/\partial l=0.4$ $W_{\mathrm{II}}=\partial\theta/\partial l\times n=0.4\times 5.0=2.0$ max $\theta=18$ min $\theta=14$

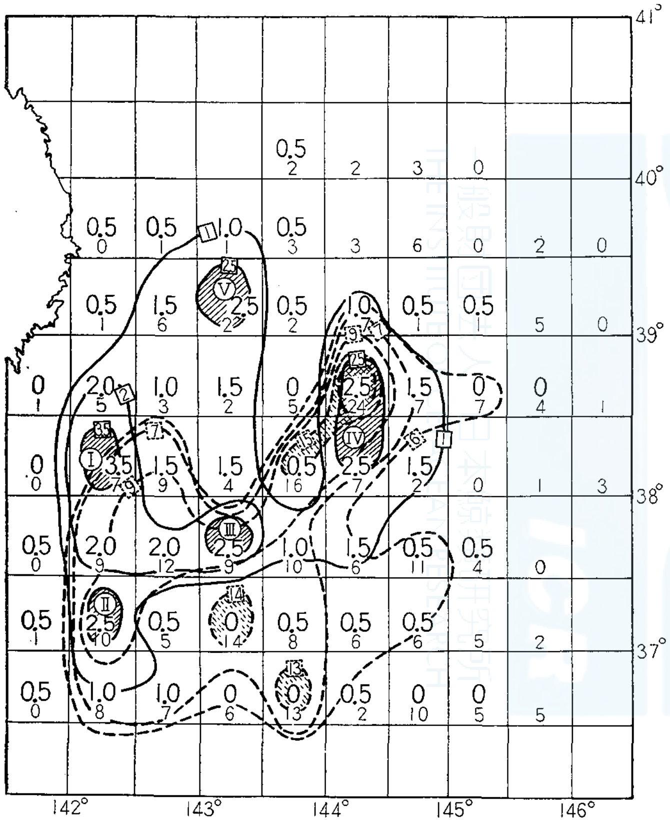
e. Middle June (1946-'54)



(I) $\partial\theta/\partial l=0.58$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.58\times 6.5=3.83$ max $\theta=20$ min $\theta=16$

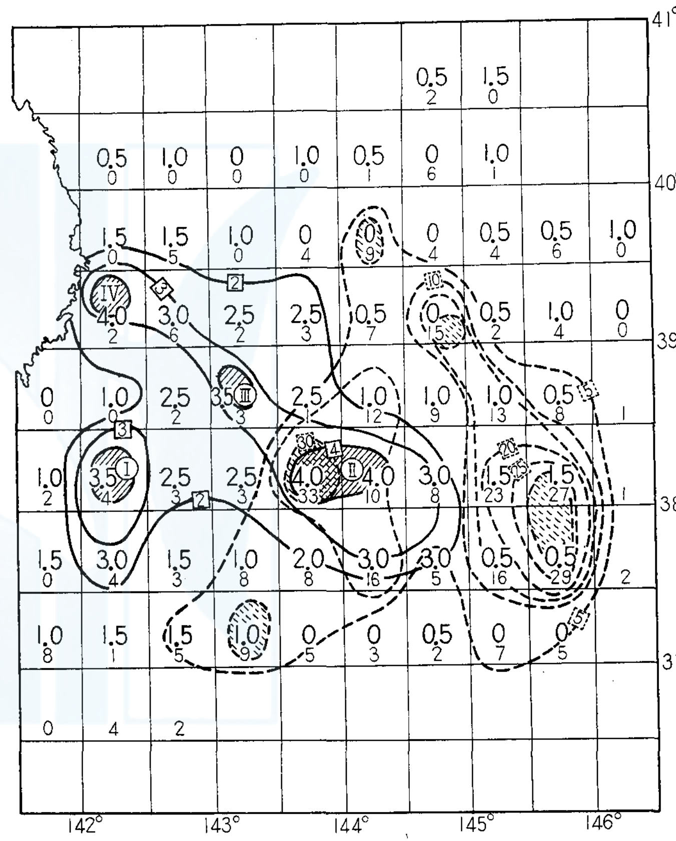
(II) $\partial\theta/\partial l=0.47$ $W_{\mathrm{II}}=\partial\theta/\partial l\times n=0.47\times 5.0=2.35$ 〃 $=2.22$ 〃 $=16$

g. Early July (1946–'54)



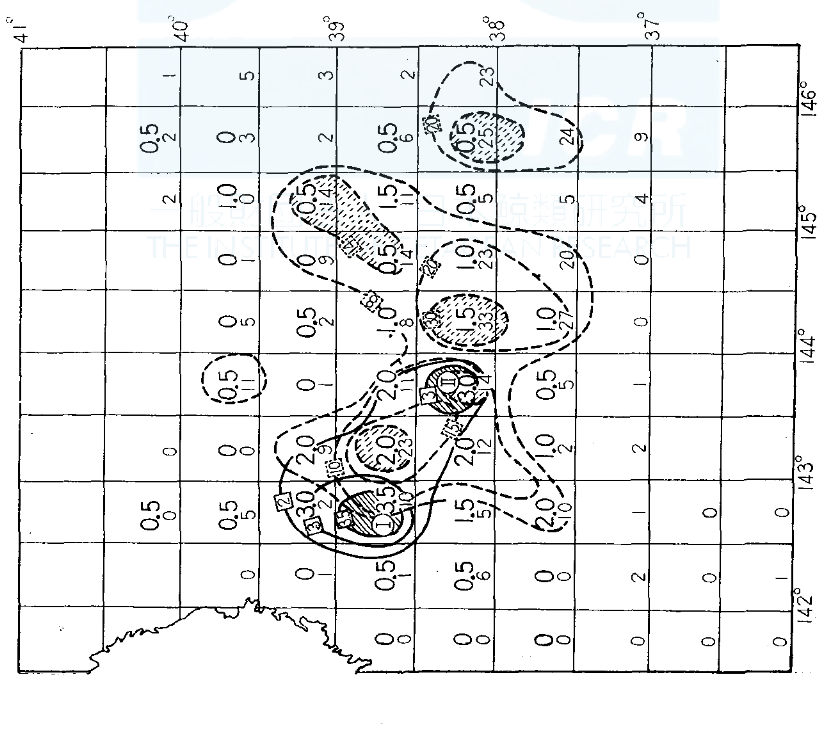
(I)	$\partial\theta/\partial l=0.4$	$W_{I}=\partial\theta/\partial l\times n=0.4\times 3.5$	max $\theta=22$	min $\theta=16$
(II)	$\partial\theta/\partial l=0.4$	$W_{II}=\partial\theta/\partial l\times n=0.4\times 2.5$	〃 22	〃 19
(III)	$\partial\theta/\partial l=0.53$	$W_{III}=\partial\theta/\partial l\times n=0.53\times 2.5=1.33$	〃 24	〃 16
(IV)	$\partial\theta/\partial l=0.45$	$W_{IV}=\partial\theta/\partial l\times n=0.45\times 2.5$	〃 21	〃 16
(V)	$\partial\theta/\partial l=0.43$	$W_{V}=\partial\theta/\partial l\times n=0.43\times 2.5$	〃 17	〃 13

h. Middle July (1946–'54)



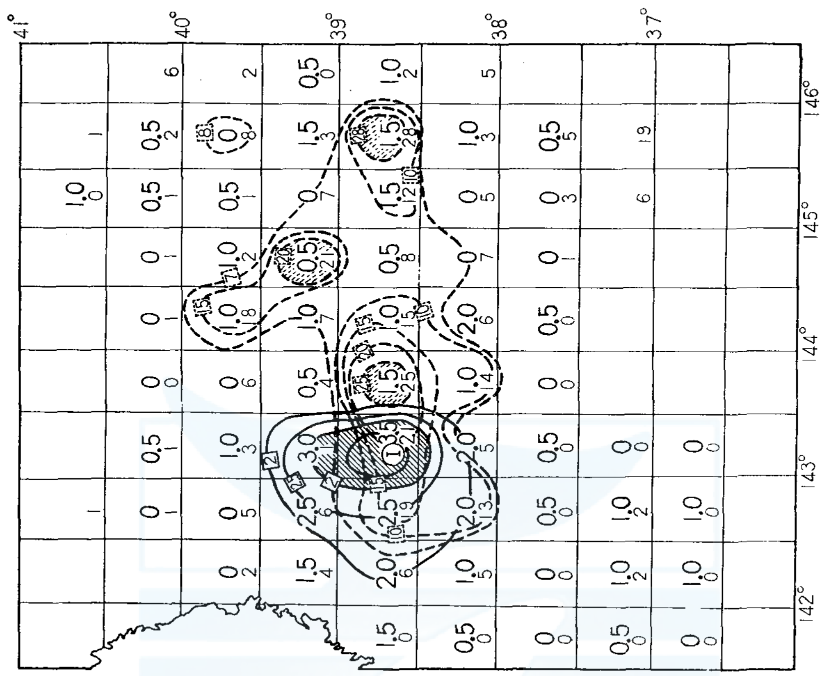
(I)	$\partial\theta/\partial l=0.48$	$W_{I}=\partial\theta/\partial l\times n=0.48\times 3.5=1.68$	max $\theta=23$	min $\theta=16$
(II)	$\partial\theta/\partial l=0.47$	$W_{II}=\partial\theta/\partial l\times n=0.47\times 4.0=1.88$	〃 23	〃 16
(III)	$\partial\theta/\partial l=0.40$	$W_{III}=\partial\theta/\partial l\times n=0.4\times 3.5=1.40$	〃 22	〃 16
(IV)	$\partial\theta/\partial l=0.44$	$W_{IV}=\partial\theta/\partial l\times n=0.44\times 4.0=1.76$	〃 21	〃 14

i. Late July (1946-'54)



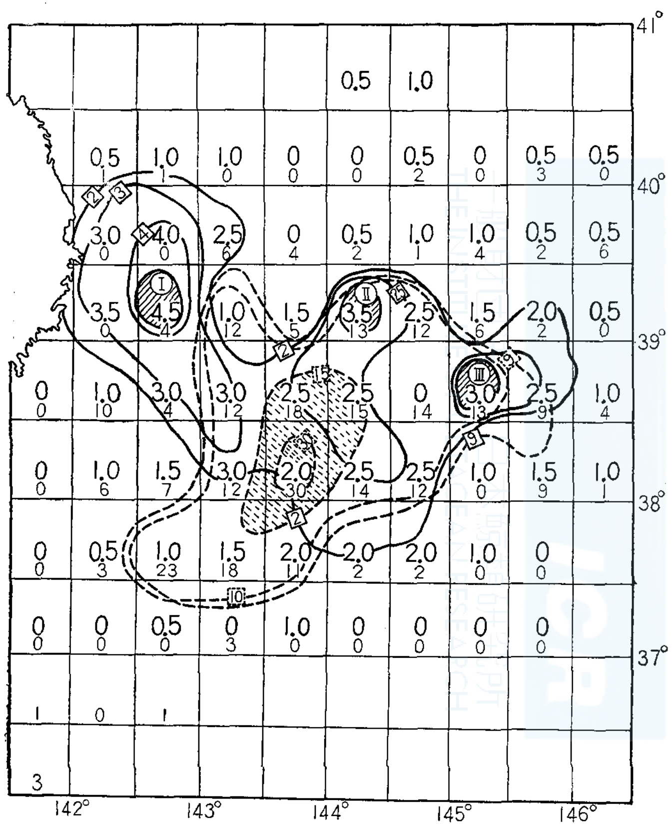
(I) $\partial\theta/\partial l=0.44$ $W_{I}=\partial\theta/\partial l\times n=0.44\times3.5=1.54$ max $\theta=25$ min $\theta=18$
(II) $\partial\theta/\partial l=0.45$ $W_{II}=\partial\theta/\partial l\times n=0.45\times3.0=1.35$ 〃 24 〃 22

j. Early Aug. (1946-'54)



(I) $\partial\theta/\partial l=0.45$ $W_{I}=\partial\theta/\partial l\times n=0.45\times3.5=1.58$ max $\theta=24$ min $\theta=21$

k. Middle Aug. (1946–'54)

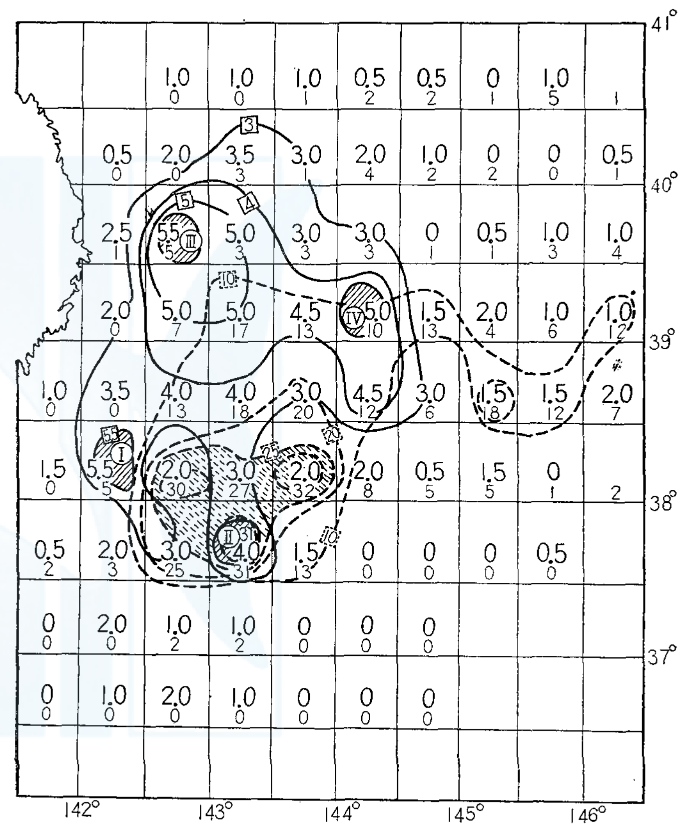


(I) $\partial\theta/\partial l=0.4$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.4\times 4.5=1.8$ max $\theta=26$ min $\theta=21$

(II) $\partial\theta/\partial l=0.4$ $W_{\mathrm{II}}=\partial\theta/\partial l\times n=0.4\times 3.5=1.4$ 〃 24 〃 20

(III) $\partial\theta/\partial l=0.4$ $W_{\mathrm{III}}=\partial\theta/\partial l\times n=0.4\times 3.0=1.2$ 〃 26 〃 20

l. Late Aug. (1946–'54)



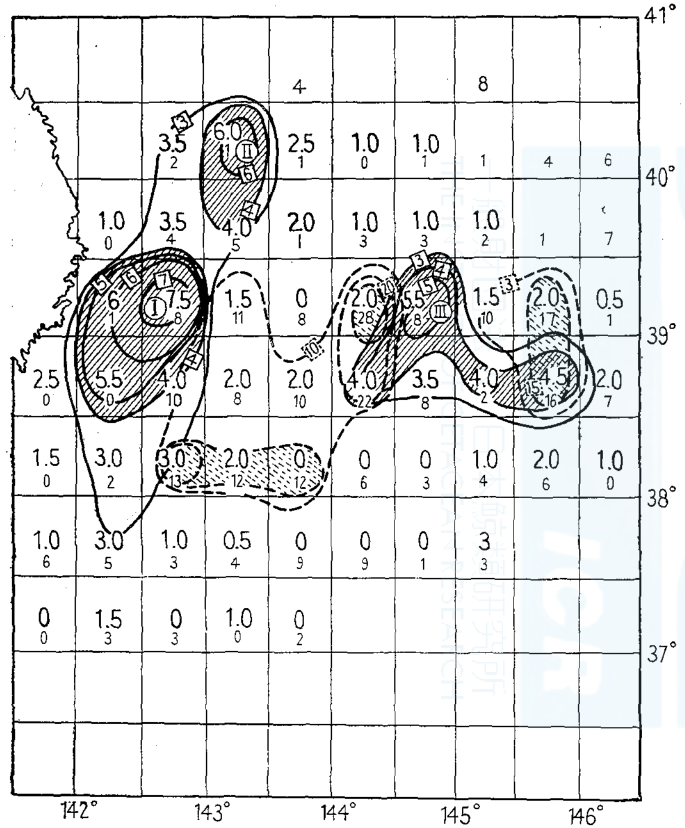
(I) $\partial\theta/\partial l=0.43$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.43\times 5.5=2.365$ max $\theta=26$ min $\theta=20$

(II) $\partial\theta/\partial l=0.40$ $W_{\mathrm{II}}=\partial\theta/\partial l\times n=0.40\times 4.0=1.6$ 〃 27 〃 24

(III) $\partial\theta/\partial l=0.42$ $W_{\mathrm{III}}=\partial\theta/\partial l\times n=0.42\times 5.5=2.31$ 〃 22 〃 20

(IV) $\partial\theta/\partial l=0.40$ $W_{\mathrm{IV}}=\partial\theta/\partial l\times n=0.40\times 5.0=2.0$ 〃 26 〃 20

m. Early Sept. (1946–'54)

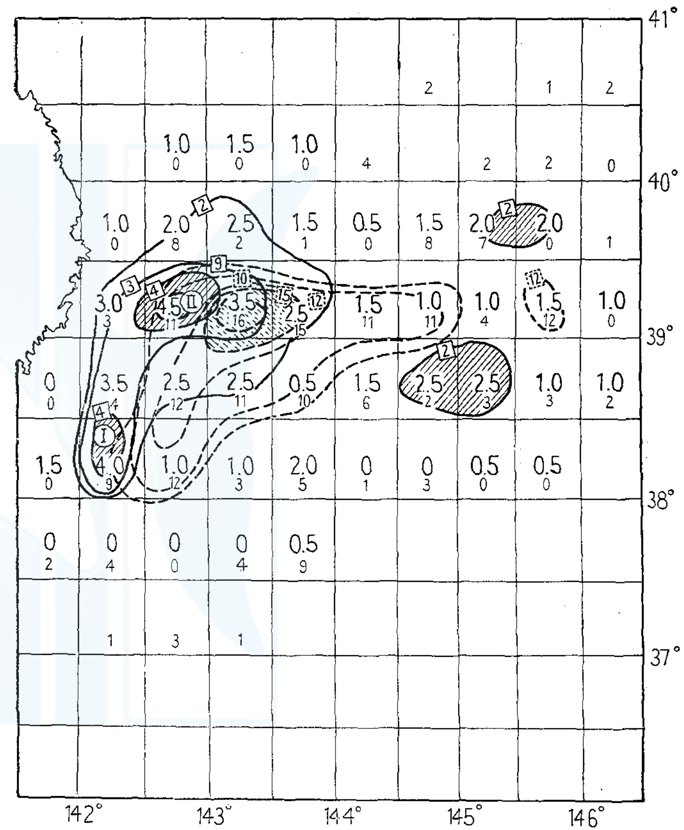


(I) $\partial\theta/\partial l=0.43$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.43\times7.5=3.23$ max $\theta=24$ min $\theta=20$

(II) $\partial\theta/\partial l=0.40$ $W_{\mathrm{II}}=\partial\theta/\partial l\times n=0.40\times6.0=2.4$ 〃 24 〃 19

(III) $\partial\theta/\partial l=0.40$ $W_{\mathrm{III}}=\partial\theta/\partial l\times n=0.40\times5.5=2.20$ 〃 25 〃 23

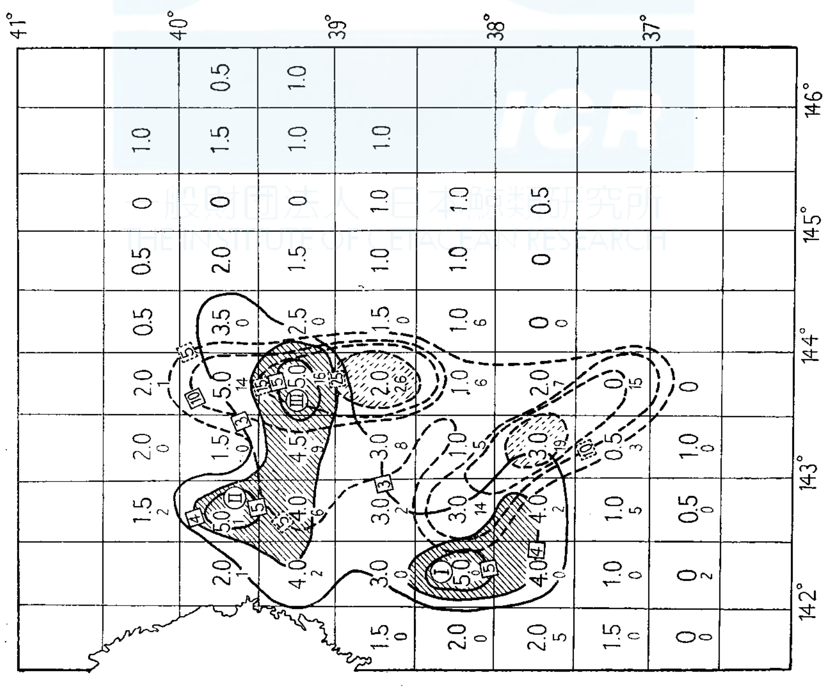
n. Middle Sept. (1946–'54)



(I) $\partial\theta/\partial l=0.43$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.43\times4.0=1.72$ max $\theta=24$ min $\theta=20$

(II) $\partial\theta/\partial l=0.50$ $W_{\mathrm{II}}=\partial\theta/\partial l\times n=0.50\times4.5=2.25$ 〃 24 〃 20

o. Late Sept. (1946–'54)

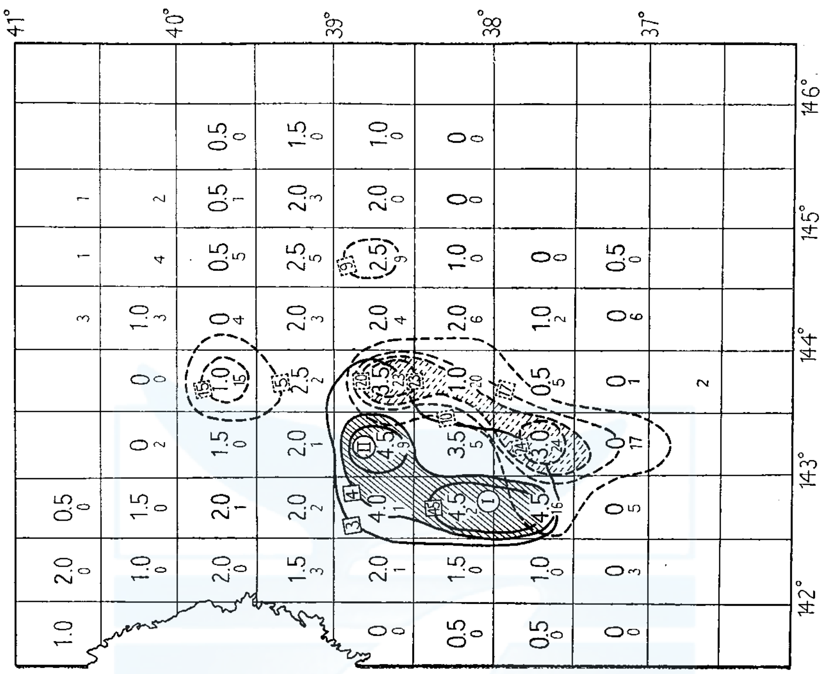


(I) $\partial\theta/\partial l=0.40$ $W_{I}=\partial\theta/\partial l\times n=0.40\times5.0=2.0$ max $\theta=24$ min $\theta=19$

(II) $\partial\theta/\partial l=0.55$ $W_{II}=\partial\theta/\partial l\times n=0.55\times5.0=2.75$ 〃 22 〃 18

(III) $\partial\theta/\partial l=0.50$ $W_{III}=\partial\theta/\partial l\times n=0.50\times5.0=2.50$ 〃 23 〃 18

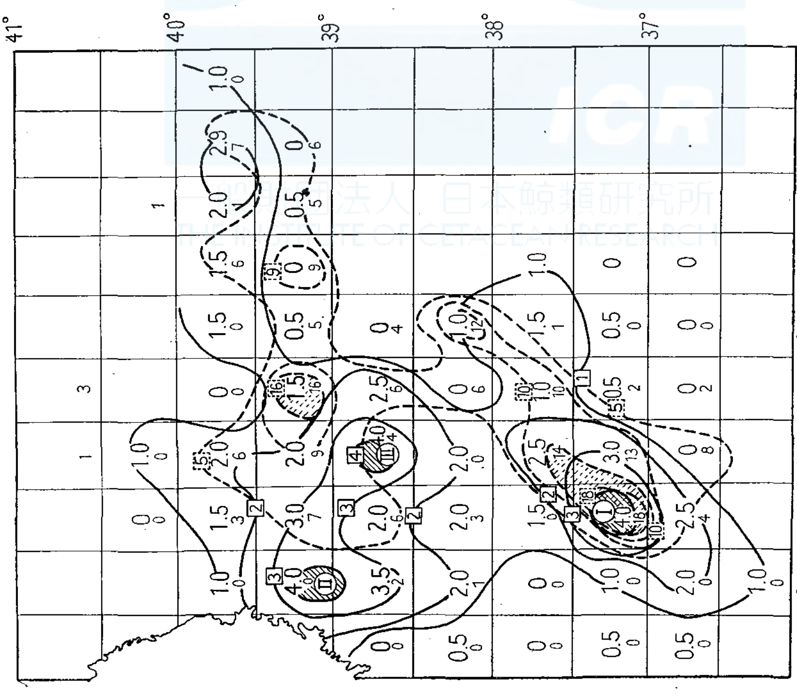
p. Early Oct. (1946–'54)



(I) $\partial\theta/\partial l=0.45$ $W_{I}=\partial\theta/\partial l\times n=0.45\times4.5=2.045$ max $\theta=22$ min $\theta=16$

(II) $\partial\theta/\partial l=0.40$ $W_{II}=\partial\theta/\partial l\times n=0.40\times4.5=1.80$ 〃 20 〃 17

q. Middle Oct. (1946-'54)

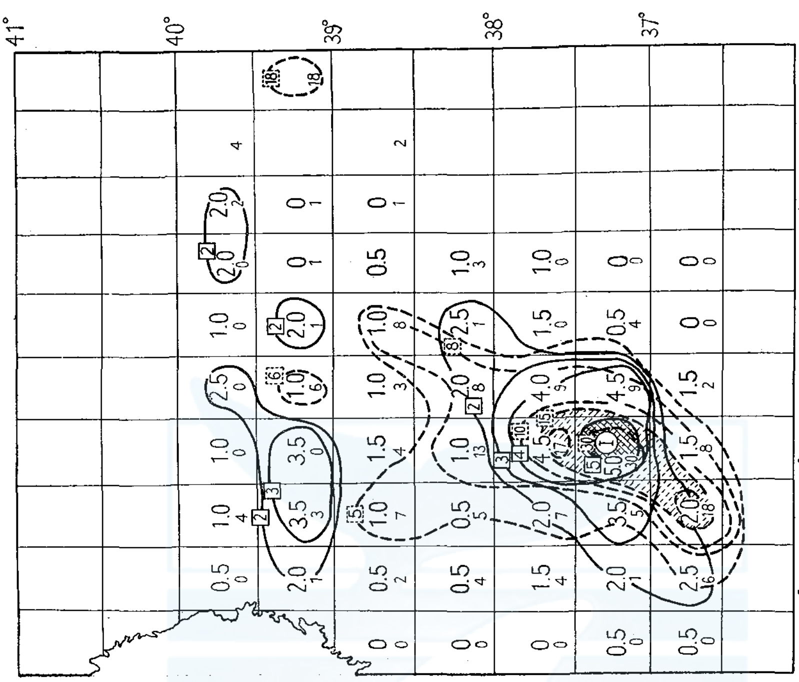


(I) $\partial\theta/\partial l=0.50$ $W_{I}=\partial\theta/\partial l\times n=0.50\times4.0=2.0$ max $\theta=22$ min $\theta=16$

(II) $\partial\theta/\partial l=0.40$ $W_{II}=\partial\theta/\partial l\times n=0.40\times4.0=1.6$ 〃 19 〃 16

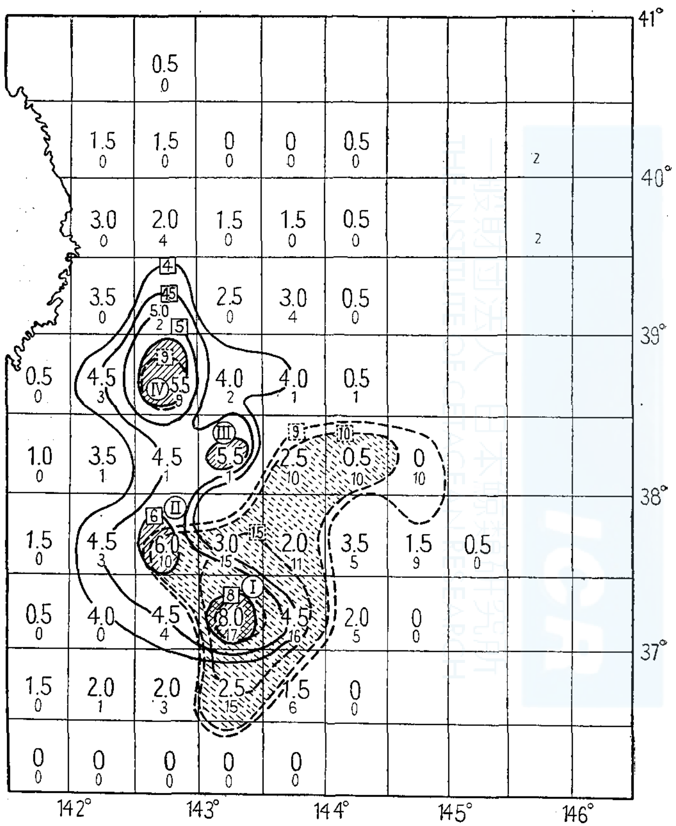
(III) $\partial\theta/\partial l=0.45$ $W_{III}=\partial\theta/\partial l\times n=0.45\times4.0=1.8$ 〃 21 〃 16

r. Late Oct. (1946-'54)



(I) : $\partial\theta/\partial l=0.63$ $W_{I}=\partial\theta/\partial l\times n=0.63\times5.0=3.15$ max $\theta=22$ min $\theta=18$

s. Early Nov. (1946–'54)



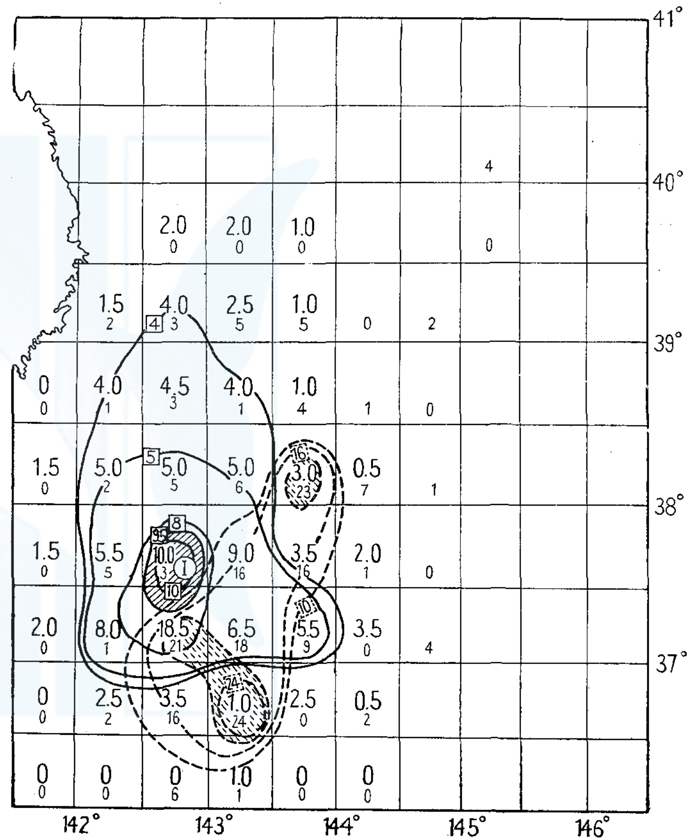
(I) $\partial\theta/\partial l=0.47$ $W_{\mathrm{I}}=0.47\times8.0=3.76$ max $\theta=22$ min $\theta=14$

(II) $\partial\theta/\partial l=0.44$ $W_{\mathrm{II}}=0.44\times6.0=2.64$ 〃 20 〃 14

(III) $\partial\theta/\partial l=0.43$ $W_{\mathrm{III}}=0.43\times5.5=2.37$ 〃 20 〃 13

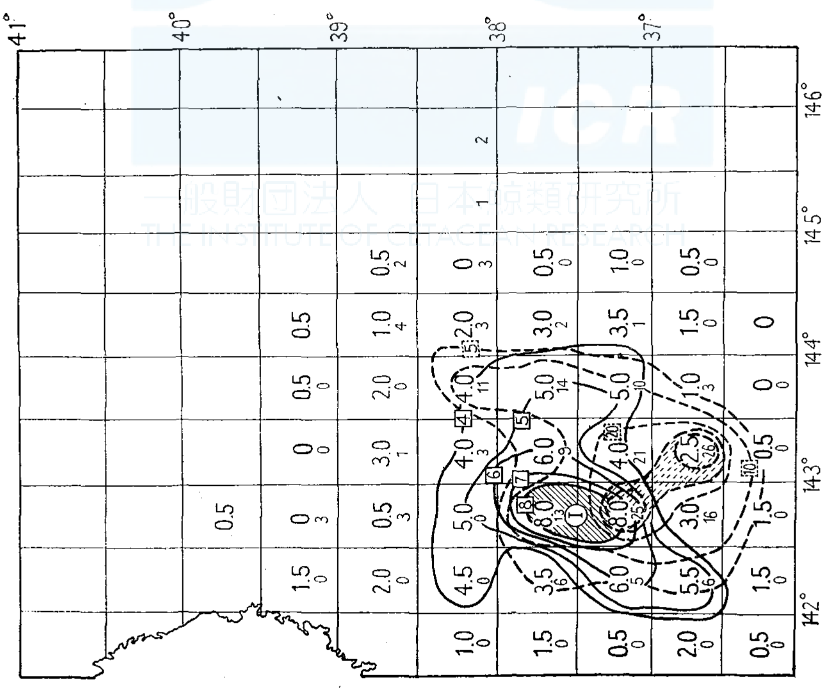
(IV) $\partial\theta/\partial l=0.47$ $W_{\mathrm{IV}}=0.47\times5.5=2.59$ 〃 20 〃 13

t. Middle Nov. (1946–'54)



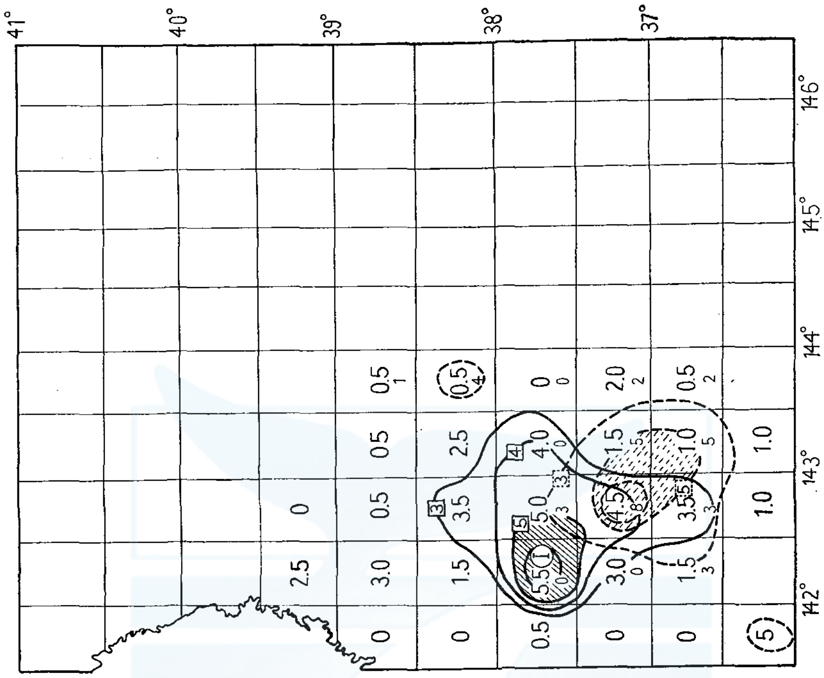
(I) $\partial\theta/\partial l=0.6$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.6\times10.0=6.0$ max $\theta=20$ min $\theta=14$

u. Late Nov. (1946-'54)



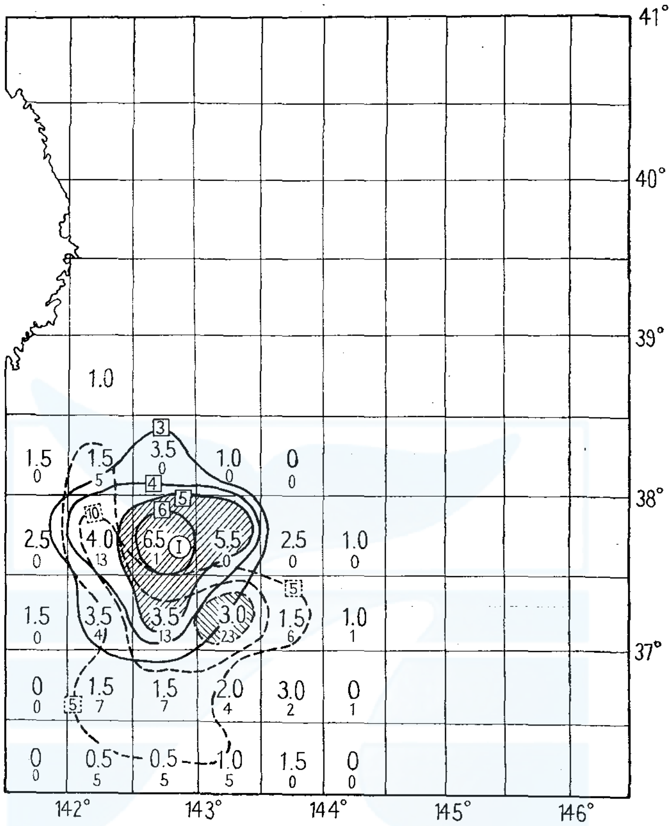
(I) $\partial\theta/\partial l=0.6$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.6\times 8.0=4.8$ $\max\theta=21$ $\min\theta=16$

v. Early Dec. (1946-'54)



(I) $\partial\theta/\partial l=0.85$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.85\times 5.5=4.68$

w. Middle and Late Dec. (1946–'54)



(I) $\partial\theta/\partial l = 0.65$

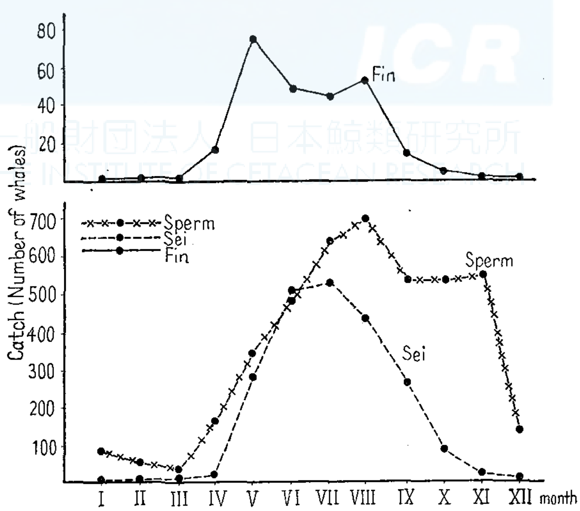


Fig. 3. Seasonal variation of the number of whales caught in each month (1946–1954).

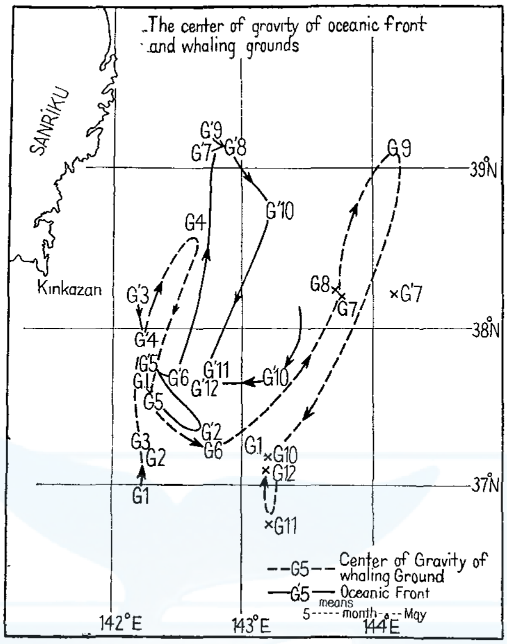


Fig. 4. The center of gravity of oceanic front and whaling grounds.