over a much wider area and time span in the same monsoon season. When it was used, the Engel II net caught more fish off Sarawak than the four-seam net in 1972, and appears to be more effective for fishing in this area; it was not tested in other areas. It is likely that the net will be experimentally tested in the near future.

The variation in the catch from haul to haul in the Tioman area was greater in 1971 than in 1972. Part of this was due to the poor catch of the first few practice hauls with the new boat and also partly due to the larger variation of catch of many more dominant fish categories, possibly as a consequence of differences in fish schooling behaviour.

5. ACKNOWLEDGEMENTS

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The Demersal Resources of the South China Sea

by

Liu Hsi-Chiang
Demersal Fish Research Center
Institute of Oceanography
National Taiwan University

Abstract

Based on the catch statistic derived from the official returns which were offered from all Taiwan paired trawlers operated in the South China Sea, dating from 1969 to 1971, the author made an investigation on the species composition, the seasonal changes of the demersal fishes appeared in their catches. The magnitude and potential of the demersal fish resources in these areas have also been assessed.

1. TOPOGRAPHY

As defined here, the northern boundary running to the north of Taiwan (25°N. 124°E), the western and southern boundaries are the mainland coast of Asia and the Malay Peninsula to 100°E, thence south to the equator, and along the equator to 117°E.

The region may be divided into seven sub-areas: the Taiwan Strait, the shelf of the Chinese south coast, the Gulf of Tongking, the Gulf of Thailand, the shelf off the Vietnam coast, the shelf off the Eastern coast of Malay Peninsula, the shelf off the northern coast of Borneo (Fig. 1).

The region includes a narrow continental shelf in the eastnorthern part and a wide area of continental shelf in the westsouthern part. These are given in Table 1 (with approximate areas in KM^2 to the 200 m contour).

Niino and Fmery (1961, 1963), Emery (1969) made a general distribution map of sediments in the continental shelf of the South China Sea, Taiwan Strait and the Gulf of Thailand (Fig. 2). Sands are predominant distributioon in the central portions of Taiwan Strait, the shelf off the South Vietnam coast, and some narrow sandy areas are present on the outer half off the Chinese south coast, northern coast of Borneo, and central east coast of Malay Peninsula.

Muds occur along Taiwan and the Chinese southeast coast to the inner shelf off the South China and the Gulf of Tongking, are predominantly distributed in the Gulf of Thailand, the shelf between Malay Peninsula and Borneo. Rocks are common on the irregular narrow shelf off Vietnam, southeast part of the Gulf of Thailand adjacent to Cambodia Coast, around the Natuna islands, around the Penghu islands in Taiwan strait, and outer shelf South of Hong Kong.

Table I. Areas of shallow water in the South China Sea (under 200 m)

Area	km^2
Taiwan Strait (Region 3)	131,000
Chinese south coast (Region 4)	217,000
Gulf of Tongking (Region 5)	202,000
Gulf of Thailand (Region 6)	332,000
Coast of South Vietnam (Region 7)	245,000
East Coast of Malaysia (Region 8)	378,000
North coast of Borneo (Region 9)	249,000

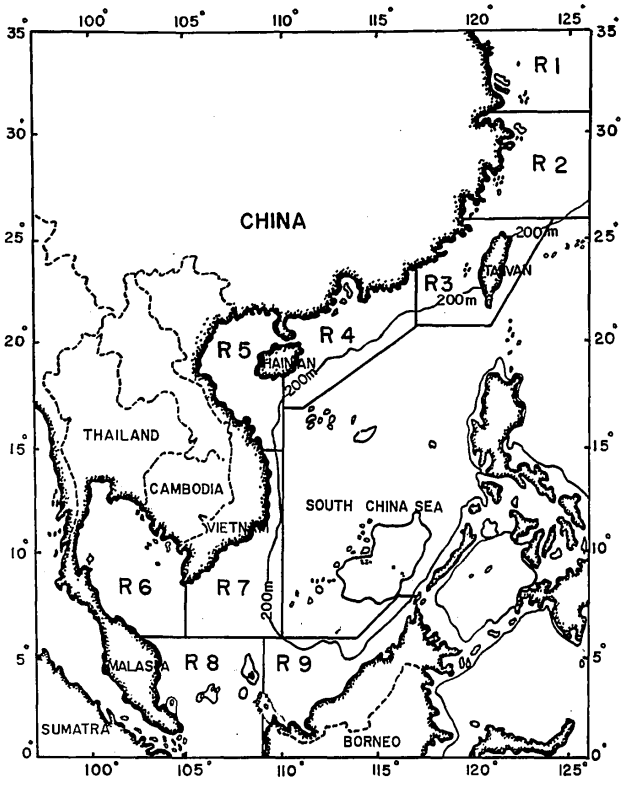

Fig. 1 Fishing grounds of Taiwan Trawling Fisheries.

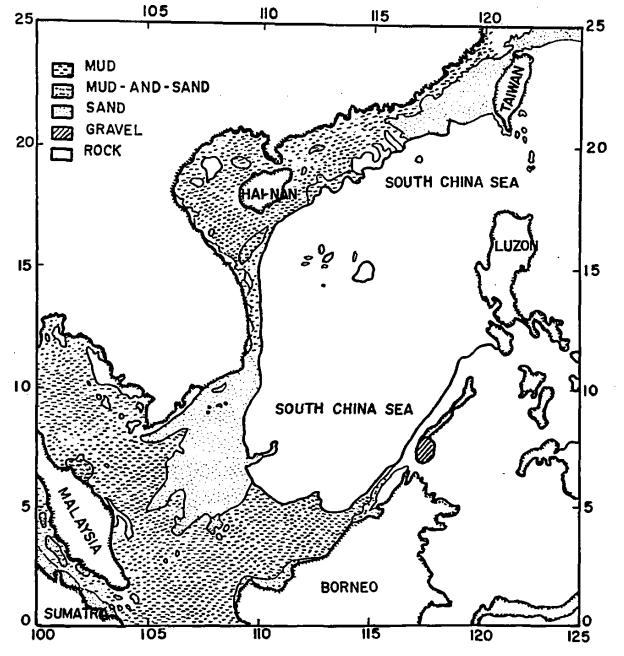

Fig. 2 Sediments chart of shallow portions of the South China Sea. (From Niino and Emery 1961, 1963, and Emery 1969)

2. FISH STOCKS AND FISHERIES

2.1 Trawling Fisheries of Taiwan

There are three types of trawling fisheries in Taiwan: (1) Drag-net fishery: The trawler is below 50 tons. It has 2,480 netters weighing 42470.39 tons, landing 98685 mt. products in 1971*. The main fishing grounds are in Taiwan Strait. (2) Otter trawl fishery: The trawler is above 50 tons. It has 163 trawlers weighing 20235.22 tons, landing 56580 mt. products in 1971*. The main fishing grounds are around the East China Sea and Taiwan Strait. (3) Paired trawl fishery: The trawler is also above 50 tons. It has 317 trawlers weighing 39949.65 tons, landing 140814 mt. products in 1971. The main fishing grounds are around the South China Sea and the water surrounding Northern Australia.

2.2 Statistics of Taiwan Trawling Fisheries

The fishing ground of the South China Sea has been demarcated into seven regions with every unit block of half degree square. Every trawler of above 50 tons has been expected to turn in the log book report as the original reference after each voyage. These reports will then be collected by the field stations of Demersal Fish Research Center at Keelung and Kaohsiung fish market. In the log book information such as exact date, position of trawling, daily working haul number, and daily datches of each species have been recorded carefully. All of the collecte data have been well arranged to get effort and catch statistics by area. This work has been in progress since 1970. A more efficient systematic data processing system with computer routine will be set up.

2.3 Stocks assessments for exploited stock

Fishing effort, total catch, and unit catch of Taiwan paired trawling fishery in the South China Sea is shown in Table II. The annual changes of fishing effort of each major fishing ground from 1969 to 1971 shows a little increment in region 6,8,9, but a great increment in region 7, and on the contrary, a great decrement in region 3,4,5. Generally speaking, the fishing efforts decreased gradually in the northern neritic area of the South China Sea and relatively increased gradually in the southwest neritic area of the South China Sea. It indicates that some trawlers which operated in the northern neritic area of the South China Sea extended gradually more and more southward. Comparing the yearly total fishing effort among different regions in 1971, it shows that region 3 hold they first position, 41% of the total. Following is region 7 with 22%, region 4 with 12%, region 5 with 10%, region 6 with 5%, region 9 with 5%, region 8 with 4%. The annual changes of total catches in each regions are proportional to the total fishing efforts expended. In region 3,4,5, there seems a decline in catch from year to year. On contrary, in region 6,7,8 and 9 reveal a increment in catch. Comparing the yearly total catch among different regions in 1971, it shows that region 3 hold the first position, 35% of total, region 7 with 26%, region 4 with 11%, region 5 with 10%, region 9 with 6%, region 8 with 6%. The unit catch among these years in each regions shows a little variety. In comparing the unit catch among different regions in 1971, it shows that there are nearly same

* Adapted from Fisheries Yearbook of Taiwan Area 1971

Table II. Fishing effort, total catch, and unit catch of Taiwan paired trawling fishery in the South China Sea from 1969 – 1971.

Region	Fishing effort (Haul)			Total catch (Cases*)			Unit catch (Cases per haul)		
	1969	1970	1971	1969	1970	1971	1969	1970	1971
R3	95,021	78,932	65,790	1,490,254	1,298,646	1,152,439	15.65	16.45	17.52
R4	38,702	32,718	19,511	704,656	589,167	357,199	18.21	18.01	18.31
R5	24,482	29,130	16,482	521,250	674,901	318,776	21.29	23.17	19.34
R6	235	301	9,037	7,472	5,732	240,450	31.80	22.66	26.61
R7	11,710	23,103	34,453	353,082	568,095	851,000	30.15	24.59	24.70
R8	17	516	6,512	500	11,817	169,760	30.59	22.90	26.07
R9	115	3,020	7,094	4,056	87,200	188,520	35.27	28.87	26.57
Total	170,282	167,720	158,879	3,081,270	3,235,558	3,278,198	18.10	19.29	20.63

* One case ≒ 26 kg

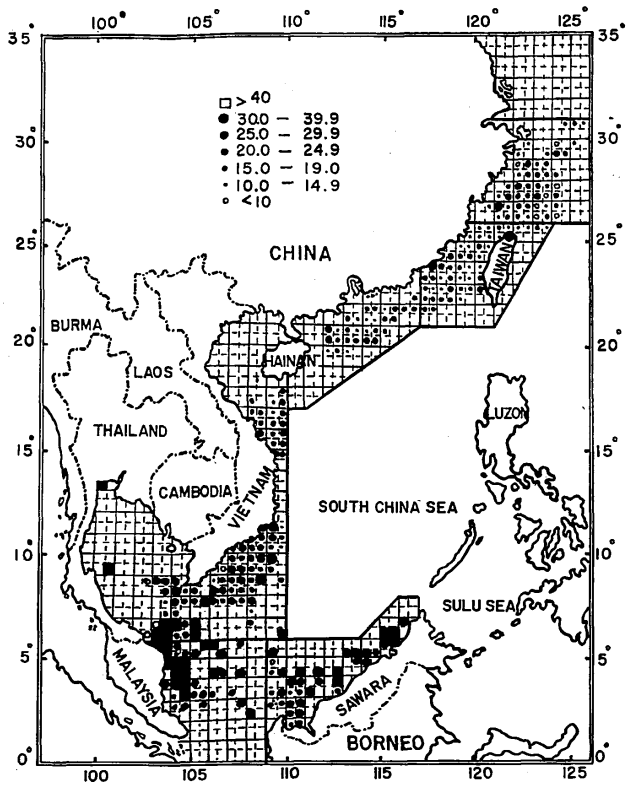

Fig. 3 Distribution of unit catch in cases per haul for ground fishes caught by Taiwan paired trawling fishery, from 1970 to 1971.

value about 26 cases per haul in region 6,7,8,9 and about 18 cases per haul in region 3,4,5. The value of unit catch in the northern neritic area of the South China Sea is about 3/4 of the southwest neritic area of the South China Sea.

2.4 The species composition of each region

The comparison of the species compositions among different regions. As shown in figure 4, the main species of region 3 are: hail-tail, *Trichiurus haumela* (species number 3); lizard fish, *Sauridatumbil* (sp. no.8); cuttle fish, (sp. no. 8); golden thread, *Nemipterus flaviventris macracanthus* (sp. no. 1); white croaker, *Agyrosomus macrocephalus* (sp. no. 21); etc.

In region 4, the main species are: golden thread, *Nemipterus mesoprion* (sp. no. 24); golden thread, *Nemipterus virgatus*(sp. no. 20); big-eye, (sp. no. 1); lizard fish, (sp. no. 8; golden thread, *Nemipterus flaviventris* (sp. no. 14); etc.

In region 5 they are: red mullet, *Upeneus bensasi*, (sp. no. 2); yellow sea bream, *Dentex tumifrons* (sp. no. 22); lizard, fish (sp. no. 8); malabar snapper, *Lutjanus malabaricus* (sp. no. 6); big-eye; golden thread (sp. no. 20); etc.

In region 6, they are: big-eye; lizard fish, *Saurida elongatus*, (sp. no. 9); sea catfish, *Ariidae spp.*, (sp. no. 4); golden thread (sp. no. 14); malabar snapper (sp. no. 6); etc.

In region 7, they are: lizard fish, *Saurida undosquamis*, (sp. no. 7); cuttle fish (sp. no. 5); golden thread, *Nemipterus marginatus*, (sp. no. 15); big-eye; common squid, *Loligo spp.*, (sp. no. 12); etc.

In region 8, they are: big-eye; red mullet (sp. no. 2); lizard fish (sp. no. 9–; sea catfish (sp. no. 4); amberfish, *Decapterus maruadsi* (sp. no. 10); malabar snapper(sp. no. 6); etc.

In region 9, they are: sea catfish (sp. no. 4); golden thread, *Nemipterus nemurus*, (sp. no. 18); pompanos, *Caranx equula*, (sp. no. 11); lizard fish (sp. no. 7); big-eye; red snapper (sp. no. 6); red-mullet (sp. no. 2); etc.

In order to compare the similarities in species composi-

Table III. Estimated demersal resources of the South China Sea

Region	Area km²	Density			Standing stock (,000 tons)
		cases/haul	cases/ha	kg/ha	
R3	131,000	16.3	1.5	39	511
R4	217,000	17.3	1.5	39	846
R5	202,000	17.8	1.6	42	840
R6	332,000	21.3	1.9	49	1,640
R7	245,000	26.2	2.3	60	1,465
R8	378,000	24.9	2.2	57	2,162
R9	249,000	31.2	2.8	73	1,813
Total	1,754,000				9,227

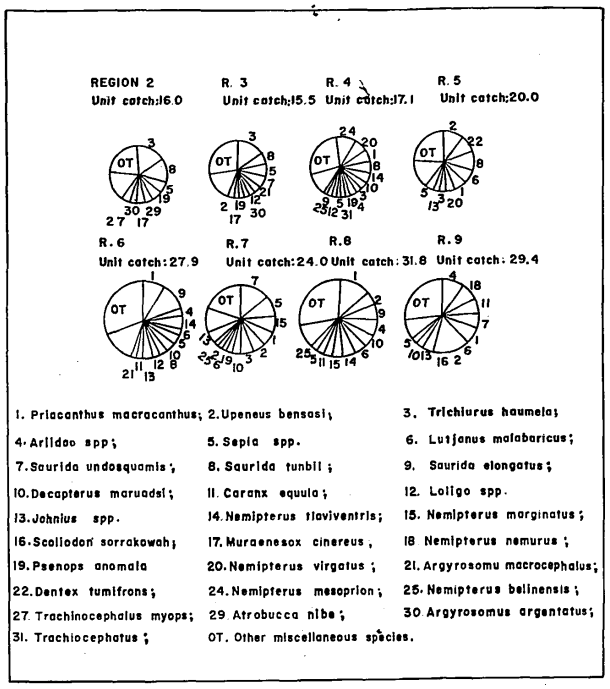

Fig. 4 Values of unit catch and species composition of eight different regions.
*Unit Catch = cases/haul 1 case = 26 kg.

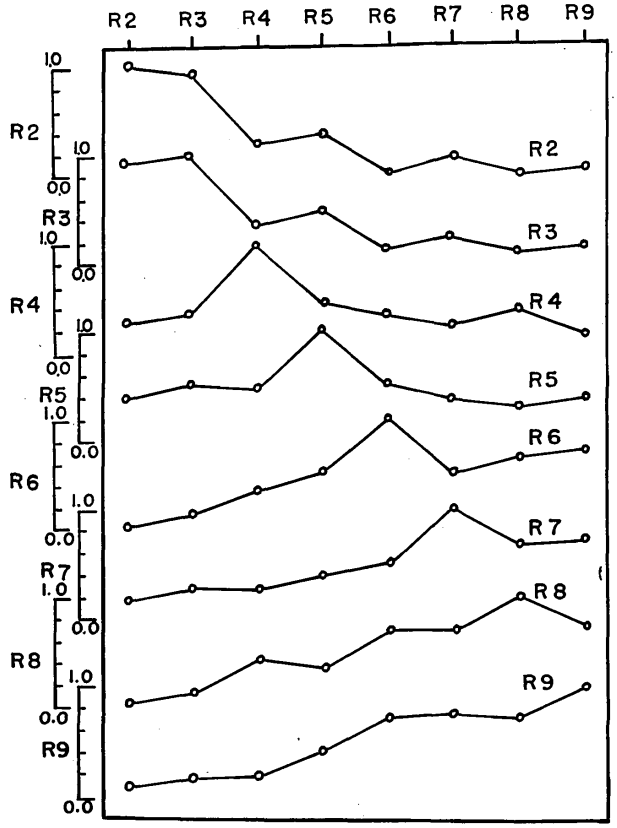

Fig. 5 Series of rank correlation coefficients obtained by the catches from eight different locaties during 1970–1971.

tions among these different regions, the Spearman's rank correlation coefficients are arranged by regions. The results are shown in figure 5.

These reveal the same curvatural tendency among regions 3, 4, 5 and among regions 6, 7, 8, 9 as well. The same tendency in curvature implies there is great resemblance in species composition among these regions.

Evidently the tendency of region 3 is much different from those of region 6, 7, 8, 9.

Above all, the figure 5 indicates that the species compositions reveal more or less differences among different regions. However, the geologically nearby areas reveal some similarities between them.

As shown in figure 4, none of the regions reveals any significant dominant species in species composition. This evidence indicates that there is a great diversity in species composition in tropical waters.

2.5 The seasonal variations of catch and species composition

2.5.1. The seasonal variation of unit catch of each species

The seasonal change of the species in unit catch are shown in figure 6-a and 6-b.

The cuttle fish (sp. no. 5) reveals an almost identical seasonal fluctuation patterns in all regions: The maximum yield seasons fromOct. to Mar. and minimum in summer time

Common squid (sp. no. 12) abundant in autumn in all regions.

Hair-tail (sp. no. 3) most abundant in north region (region 3) in winter and spring time, in region 7 it is abundant in autumn.

All the other species and the other miscellaneous species show no significant seasonal changes. The total unit catches also show no significant seasonal changes.

2.5.2 The seasonal variation of species composition

In order to clarify the seasonal change of species composition the Spearman's rank correlation coefficient are arranged by successive seasons in each region, as shown in figure 7.

The curves between A and B seasons and between C and D seasons in each region show same resemblance tendency, but between A, B and C, D seasons they show a little difference. Therefore, there are a few seasonal change in species composition in each region.

3. SUMMARY AND DISCUSSION

The general bottom sediments of the areas are as follows:
Taiwan Strait: sand, with rocks around Penghu islands.
South of Hong Kong: mud, with rocks.
Gulf of Tonking: mud
South Vietnam coast: sand, with rocks on the narrow self off Vietnam.
Gulf of Thailand: mud
Between South Malay Peninsula and Borneo: mud, with rocks around Natuna islands.

All of these areas, except the inner part of the Guf of Thailand and the Gulf of Tonking, have been operated by Taiwan paired trawlers. The workable trawling areas evidently are those of sandy and muddy areas.

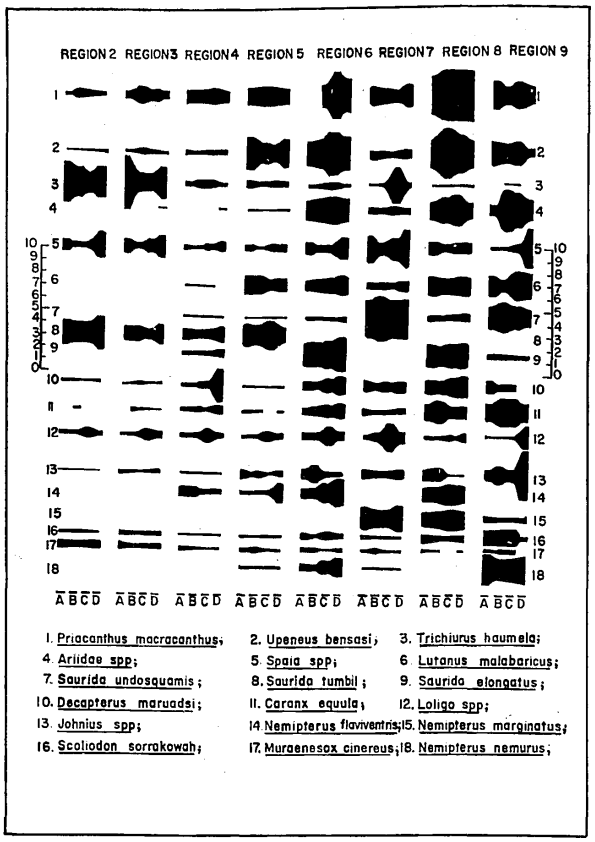

Fig. 6a The seasonal changes of unit catch of each species.
*A: Jan.–Mar. B: Apr.–Jun. C: Jul.–Sep. D: Oct. –Dec.

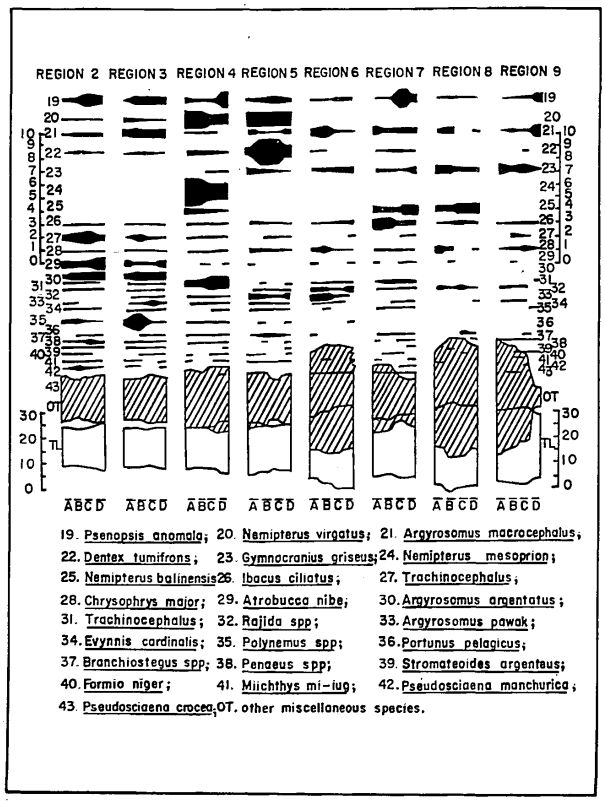

Fig. 6b The seasonal changes of unit catch of each species. (continued)
*A: Jan.–Mar. B: Apr.–Jun. C: Jul.–Sep. D: Oct. –Dec.

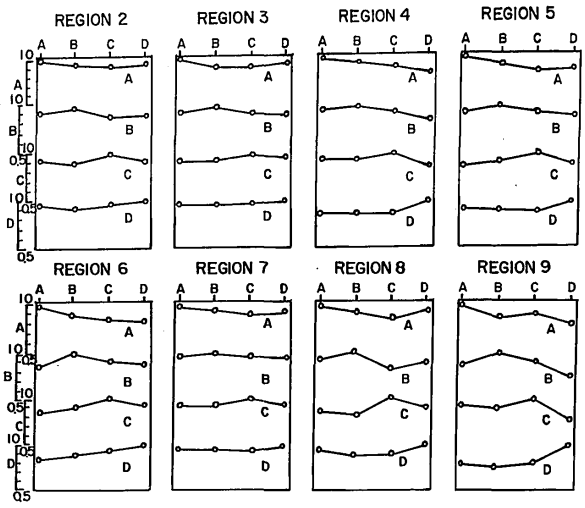

Fig. 7 Series of rank correlation coefficients obtained from four successive seasons.

The species compositions reveal more or less differences among different regions. However, the geographically nearby areas reveal some similarities among them. They also reveal a great diversity of species without any being really dominant and a little seasonal change in species composition in each region. Most presently used population dynamics models, and management practices, were typically developed for individual temperate water species, often long lived. So attention should be focussed on preparing modes on a multi-species or community basis.

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