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东海区伏季休渔渔业生态效果的分析研究

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摘 要 以1990~1998年我国东海区的海洋渔业统计资料和渔业资源动态监测资料为依据,分析研究1995~1998年伏季休渔对东海区渔业生态效果的影响。结果表明,带鱼等主要经济鱼类的产卵群体得到了有效保护;经济幼鱼的渔获比例及其资源密度指数有所提高,幼鱼群体养护效果也较明显;渔获个体的生物学特征值具有转好的趋势;主要经济鱼类资源生物量明显增加;渔业资源的种间结构得到一定程度的改善;年渔获产量明显增加,单位捕捞努力量渔获量(CPUE)有所提高。

关键词 东海区,伏季休渔,渔业生态

东海区广阔的沿岸近海水域是东黄海主要经济鱼类的天然良好产卵场与索饵场,每年春夏汛期间带鱼、大黄鱼、小黄鱼、银鲳、白姑鱼等鱼种均洄游到此海域进行产卵索饵,在渔业生产上占有极其重要的地位。自70年代末期起,由于渔业生产和环境因子的变化,海洋捕捞力量恶性超速增长,至90年代初期东黄海区近海传统经济鱼类资源更是发生了较大变化,呈现出严重衰退的局面。针对这些经济鱼类渔获个体日趋小型化、低龄化、性成熟提早的严峻生物学表现[1],我国政府于1995年正式宣布对东黄海海域实施伏季休渔制度。东海区休渔范围为27°00 N~35°00 N的东黄海海域,时间为每年的7月1日~8月31日。经过3年实践,1998年又在此基础上将时空进一步扩大到26°00 N~35°00 N海域,将时间延长至每年的6月16日~9月15日。4年来该制度得到了全面的贯彻执行,并取得了公认的生态效益、经济效益和社会效益。但到目前为止仍未见有关对伏季休渔生态效果科学评价的文献报道,故本文根据近年来对东海区渔业资源连续监测的结果,从渔业生物学表现、渔业资源生物量变化等方面,分析研究了伏季休渔制度对东海区渔业生态效果的影响,并以此来佐证伏季休渔制度在我国现行海洋渔业形势下的科学意义及实施它的迫切性与必要性,为进一步在东海区开展增殖和有效的渔业管理提供科学依据。

1 材料与方法

分析数据取自1990~1998年东海区海洋渔业统计资料和东海区渔业资源动态监测资料。从主要经济鱼类生殖群体的产卵时间和比例、经济幼鱼渔获比例及其资源密度指数、渔获个体的生物学特征值、资源生物量、渔获产量和单位捕捞努力量渔获量(CPUE)等多方面,对实施伏季休渔制度前后的变化结果进行分析研究,并以此来阐述东海区伏季休渔制度的渔业生态效果。

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2 结果与分析

2.1 伏季休渔期主要经济鱼类产卵群体的比例

1996~1998 年伏季休渔期间长江口渔场带鱼性成熟个体比例的变化情况见表 1。带鱼作为我国海洋渔业的支柱鱼种，每年的产卵高峰期主要集中在 6、7、8 月[2~8]。6 月其性腺成熟度为Ⅲ期以上能产卵的个体占到当月雌性比例的 40.0%，7 月占 91.1%，8 月占 57.4%，而 9 月下降到 15.0%（表 1）。由此可见，伏季休渔的禁渔期正好是带鱼产卵高峰期，这一时间段内实施伏季休渔，避免了人为酷渔滥捕产卵群体的违反自然生态行为，而 9 月 16 日禁捕期过后，基本上错过带鱼的高峰产卵行为。此外，白姑鱼、银鲳等经济鱼类的生殖行为也主要集中在夏季。因此，伏季休渔制度的实施对夏季集中产卵的群体起到了关键有效的保护作用。

表 1 1996~1998 年伏季休渔期间长江口渔场带鱼性成熟个体比例的变化

Table 1 The changes of sex maturity in the Changjiang estuary during the close season in summer from 1996 to 1998

月份 month	测定样品数 sample numbers	雌性数 female numbers	性腺Ⅲ期以上数 numbers of gonad over stage Ⅲ	性成熟/% percentage of sex maturity
6 月 Jun	324	120	48	40.0
7 月 Jul	380	213	194	91.1
8 月 Aug	528	317	182	57.4
9 月 Sep	297	120	18	15.0

2.2 近海经济幼鱼的渔获比例及其资源密度指数

东海区自 1995 年实施伏季休渔制度后，由于伏季休渔期间很大程度上限制了对幼鱼资源破坏严重的渔具渔法在渔场的投人，使得渔场渔业环境的人为破坏因素在一定时空内得到了控制，渔场渔业生态环境相应也随之得以改善，这就大大减轻了幼鱼被捕杀的程度，为幼鱼在渔场内的自然生息创造了较好的环境。表 2 中的数据反映了 1990~1998 年 6~9 月浙江省沿海张网主要经济鱼类幼鱼的渔获组成及其资源密度指数的变化情况。由表 2 可见，伏季休渔制度实施后张网的日均网产量较实施前有所提高，其平均值增幅为 14.38%。带鱼、大黄鱼、小黄鱼、银鲳、鳓鱼、乌贼六种主要经济幼鱼的张网渔获中的比例均呈增加趋势，特别是小黄鱼和银鲳的增幅更为显著。其中 1995~1998 年 6~9 月小黄鱼和银鲳占渔获物的相对比例平均值分别为 6.34%、9.04%，而 1990~1994 年同期平均值分别只有 1.84%、1.19%，后 4 年较前 5 年的增幅达数倍。90 年代 6~9 月幼带鱼在张网渔获物中的比例虽时有波动，但总的情况仍呈增加趋势，特别是伏休制度实施后，幼带鱼相对密度增加较为明显。其渔获比例平均值由 1990~1994 年的 24.51% 增加到 1995~1998 年的 30.68%，增长了 6 个百分点。其资源密度指数平均值也由伏季休渔制度实施前的 8.61 kg/d·net 增加到伏季休渔制度实施后的 12.18 kg/d·net，增幅为 41.46%。

2.3 渔获个体生物学特征值的变化

从表 3 中东海区的不同渔场、不同渔法渔获个体生物学特征值的监测数据来看，在伏季休渔制度实施前后，带鱼长江口渔场拖网的渔获平均肛长增大 8 mm，平均体重增重 11.7 g；而浙江省沿海张网的渔获平均肛长增大 11 mm，平均体重增重 2.1 g。小黄鱼吕泗渔场帆张网的渔获平均体长增大 9 mm，平均体重增重 6 g。银鲳吕泗渔场帆张网的渔获生

表 2 1990~1998 年 6~9 月浙江省沿海张网主要经济幼鱼的渔获组成及幼带鱼密度指数

Table 2 The catch compositions of main commercial juveniles and the density indices of hairtail juveniles in the stake net off Zhejiang coast during Jun to Sep 1990~1998 %

项目 item	年份 year								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
日均网产量 daily average catch per net	32.61	35.40	37.70	33.04	34.90	38.60	40.13	41.73	38.44
6 种经济幼鱼 six commercial juveniles	15.05	25.11	33.44	26.92	33.74	36.67	45.91	46.33	55.43
带鱼 *Trichiurus haumela*	13.08	21.40	32.56	23.32	32.20	34.55	23.92	32.96	31.27
小黄鱼 *Pseudosciaena polyactis*	0.01	0.74	0.01	—	0.16	1.12	15.22	1.38	7.65
银鲳 *Pampus argenteus*	0.88	2.24	0.12	1.31	1.38	0.97	6.71	11.98	16.51
幼带鱼密度指数/[kg·(d·net)$^{-1}$] density indices of hairtail juveniles	4.27	7.58	12.28	7.70	11.24	13.34	9.60	13.75	12.02

物学特征值变化差异不大。由图 1 可见,长江口渔场 1990～1994 年(总测定样品数 n = 3 363 尾)和 1995～1998 年 6～9 月(总测定样品数 n=2 700 尾)的带鱼体长百分比组成的变化趋势定量而客观形象地反映了这一结论。个体肛长大于 210 mm 的尾数占总测定尾数的百分比,在实施伏季休渔制度后为 19.5%,而实施伏季休渔前仅为 10.4%,提高了 9.1 个百分点。可见,4 年的伏休对于带鱼、小黄鱼、银鲳等幼鱼的养护效果都较为明显。带鱼、小黄鱼个体出现增大趋势,银鲳个体相对基本稳定。

表 3 1990～1994 年和 1995～1998 年 6～9 月主要经济鱼种平均体长及平均体重的变化

Table 3 Variations of average length and average weight of major commercial fish in 1990～1994 and during Jun to Sep 1995～1998

时间 time	平均体长、体重 average length & weight	带鱼 *Trichiurus haumela* (拖网) trawl net	带鱼 *Trichiurus haumela* (张网) set net	小黄鱼 *Pseudosciaena polyactis* (帆张网) stake net	银鲳 *Pampus argenteus* (帆张网) stake net
1990～1994	L/mm	176	66	141	179
	W/g	84.6	4.7	46	167
1995～1998	L/mm	184	77	150	178
	W/g	96.3	6.8	52	168

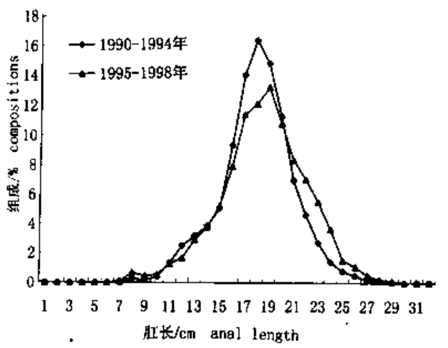

图 1 长江口渔场 1990～1994 年和 1995～1998 年 6～9 月带鱼肛长(*L*)百分比组成

Fig. 1 The percentage compositions of anal length (*L*) of hairtail on the fishing ground of the Changjiang estuasy in 1990～1994 and from Jun to Sep 1995～1998

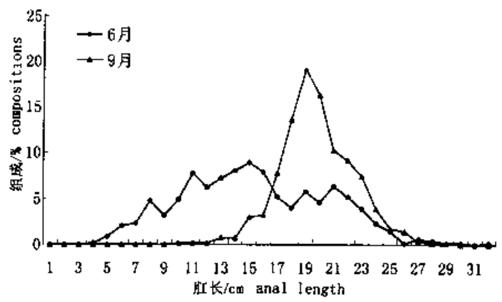

图 2 长江口渔场 1995～1998 年 6 月和 9 月带鱼肛长(*L*)百分比组成

Fig. 2 The percentage compositions of anal length (*L*) of hairtail on the fishing ground of the Changjiang estuasy in Jun and Sep 1995～1998

2.4 伏季休渔对主要经济鱼类资源生物量的影响

仅以长江口渔场带鱼的监测资料来定量分析(图 2),长江口渔场 1995～1998 年 6 月(总测定样品数 n=693 尾)和 9 月(总测定样品数 n=563 尾)的带鱼肛长百分比组成中,9 月的带鱼优势肛长明显大于 6 月的优势肛长。9 月的平均肛长为 193 mm,平均体重为 110.6 g,而 6 月的平均肛长为 156 mm,平均体重为 59.5 g,可见 3 个月的东海区伏季休渔期带鱼平均肛长增加了 39 mm,每尾平均增重 51.1g。据此推算:假设 6 月捕捞 1 t 带鱼,则将相应损害带鱼幼鱼群体资源 1.68 万尾,为撇开带鱼幼鱼群体的自然死亡和可捕标准不论,待禁渔期过后,当该批幼鱼群体作为补充群体加入到秋冬汛再利用时,则至少会形成 1.86 t 的捕捞产量,比原先捕捞净增产 0.86 t。由此得出结论,伏季休渔制度客观上无疑对幼鱼群体起到了养护作用,其显著的渔业生态效果则体现在主要经济鱼类的资源生物量均得到了明显的增加。

2.5 伏季休渔对近海渔业资源群落结构的影响

伏季休渔的生态效果,反映在渔业资源生物学

上主要表现为产卵群体、幼鱼群体得到了保护与养护，资源生物量有所提高，而反映在渔业生态学上主要表现为渔业资源群落结构出现好转。由东海区海洋渔业统计资料分析(表4)，90年代伏季休渔制度实施前后，历史上资源状况良好时的主要经济鱼类渔获量占总渔获量比例除带鱼下降了2.42个百分点、鳓鱼基本保持稳定外，其余种类均有所提高，增长的百分点大黄鱼为0.16、小黄鱼为0.79、乌贼为0.06、银鲳为0.98、篮点马鲛为0.12、海鳗为0.13。这也可从另一个侧面说明了伏季休渔制度实施后渔业资源的种间结构出现了向好的方面转变的迹象，渔业资源群落结构得到了一定程度的改善，伏季休渔对恢复渔业资源的种间生态平衡具有一定的作用。

表4 1990～1998年东海区主要经济鱼类渔获量占总渔获量的比例

Table 4 Percentage of major commercial fish catches in total catches in the East China Sea during 1990～1998 %

时间 time	种类 species							
	大黄鱼 *Pseudosciaena crocea*	小黄鱼 *Pseudosciaena polyactis*	带鱼 *Trichirus haumela*	乌贼 *Sepiella*	银鲳 *Pampus argenteus*	鳓鱼 *Ilisha elongata*	篮点马鲛 *Scomberomorus niphonius*	海鳗 *Muraenesox cinereus*
1990～1994	0.15	0.86	16.80	2.12	1.88	0.37	1.48	2.13
1995～1998	0.31	1.65	14.38	2.18	2.86	0.35	1.60	2.26
增减 variance	0.16	0.79	-2.42	0.06	0.98	-0.02	0.12	0.13

表5 1990～1998年伏季休渔制度实施前后渔获量的平均值差异

Table 5 The different average catches before and after the implementation of the system of close season in summer during 1990～1998 万t

渔获量类别 catches	年份 year		增幅/% amplitude
	1990～1994	1995～1998	
总渔获量 total catches	295.89	544.08	83.9
带鱼 *Trichiurus haumela*	49.72	77.49	55.9
小黄鱼 *Pseudosciaena polyactis*	2.52	8.99	256.5
银鲳 *Pampus argenteus*	5.55	15.55	180.2

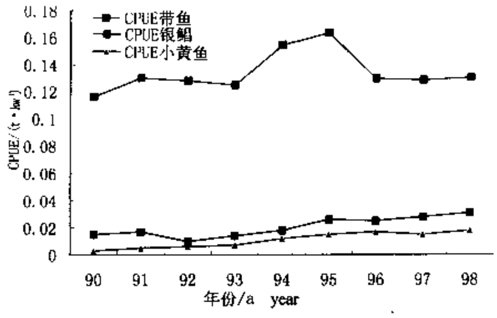

图4 1990～1998年东海区海洋渔业主要经济鱼类CPUE的变化

Fig. 4 Changes of CPUE in the main commercial fishes of marine fisheries in 1990～1998

2.6 伏季休渔对渔获产量及单位捕捞努力量渔获量(CPUE)的影响

评价海区渔业资源生物量的好坏，最直观的反映表现为渔获量的高低，较为客观的方法可从单位捕捞力量渔获量的变化中得到比较。由表5可见，伏季休渔制度实施前东海区海洋捕捞总产量处于230～400万t级水平，而实施伏季休渔制度后，东海区海洋捕捞总产量却迅速提高到480～610万t。海洋捕捞平均总产量由伏季休渔制度前的295.89万t增加到实施后的544.08万t，增幅为83.9%。主要经济鱼类中的带鱼平均总产量由伏季休渔制度实施前的49.72万t增加到实施后的77.49万t，增幅为55.9%。小黄鱼平均总产量增幅为256.5%。鲳鱼

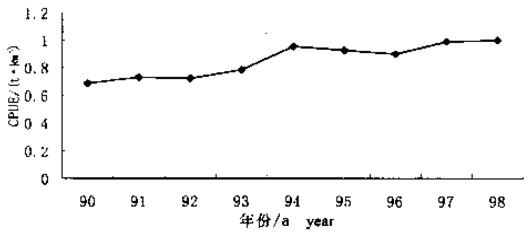

图3 1990～1998年东海区海洋渔业总渔获量CPUE的变化

Fig. 3 Changes of CPUE in the total catches of marine fisheries in the East China Sea region during 1990～1998

平均总产量增幅为180.2%。图3、图4的曲线变化趋势也直观地说明了伏季休渔制度实施后的CPUE较之实施前有了明显的提高。总渔获量的CPUE由伏季休渔制度实施前的0.687～0.784 t/kw增加到实施后的0.901～1.004 t/kw，平均值增加0.226 t/kw，增幅为30.9%。带鱼的CPUE由伏季休渔制度实施前的0.116～0.130 t/kw增加到实施后的0.129～0.164 t/kw，平均值增加0.014 t/kw，增幅为11.2%。小黄鱼的CPUE平均值增加0.01 t/kw。银鲳的CPUE平均值增加0.014 t/kw。

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Analyses on the fishery ecological effect of summer close season in the East China Sea region

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Abstract　Based on the marine fisheries statistical data and marine fisheries dynamic monitoring data in the East China Sea region from 1990 to 1998, the paper analyses the effect of summer close season in the last four years (1995～1998) on the marine fisheries ecology in the East China Sea region. The studied results show that some of the commercial spawning stocks have been effectively protected; the catch rate of commercial juveniles and the stock density indices have increased, while the larvae stocks have been conserved; the biological characteristics of the stocks caught have a tendency to improve; the biomass of the major commercial fish stocks have significantly risen; the interspecific structure of fishery resources has improved to a certain extent; the annual catch has showed a sharp rise with an increase of CPUE.

Key words　East China Sea region, summer close season, fisheries ecology

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A study on the development future of light - seine fishery in the Taiwan Strait

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Abstract In order to approach the developing future of light - seine, the marine fishing data of Fujian Province fishing in the Taiwan Strait (50 sample light - seiners) from 1986 to 1996 and some marine environmental factors in the upwelling areas were collected and analyzed with mathematical and statistical method, Schaefer and Fox models, the least squares method and from the viewpoint of ecology. The results show that there are many upwelling regions in the Taiwan Strait, where large quantities of plankton and stable hydrological conditions are favorable for fish to concentrate and feed. The fishing practice of light - seine has relatively smaller effects on the marine geologic environment and young fishes. The growth cycle of pelagic fish is shorter and the generation recruitment is quicker. It is eváluated that the pelagic fish stocks are 640 000 t with catchable yields of 330 000 t, therefore, the stocks are abundant and have some exploited potentialities. The light - seine fishery in the Taiwan Strait has a bright future. However, since the CPUE(catch per unit of effort) of light - seine in 1996 was below the highest point of the regression curve of growing tendency, the fishing effort should not be blindly increased from the viewpoint of economic benifits.

Key words light - seine fishery, purse seine fishing, stock assessment, the Taiwan Strait

There are abundant pelagic fish in the Taiwan Strait, especially in the Minnan - Taiwan shallow shoal, where the light - seiners have been used over years. Recently, the yield is still remaining relatively smooth in spite of the reduction in the number of light - seiner. On the basis of environmental characteristics of the fishing grounds and the state of fish resources, selecting a correct developing direction has become the key to develop the marine capture fisheries in the strait steadily and continuously.

1 Materials and methods

1.1 Data sources

The production data about capture fisheries of Fujian Province from 1986 to 1996 were taken from annual fisheries statistics in Fujian Province. Fifty sample light - seiners with main engine power of 80 ~ 400 kW fishing in the Taiwan Strait were taken for examples. The information about upwelling regions was taken from the results of the subject " Minnan - Taiwan Bank Fishing Ground Upwelling Ecosystem Study" investigated cooperatively by Xiamen University, Fujian Fisheries Research Institute and Fujian Institute of Oceanology in 1991[1].

2.2 Methods

The present production situation was analyzed with mathematical and statistical methods. The relationship between the environmental characteristics of fishing grounds was analyzed by ecological theory[2]. The stock size and catchable yields were assessed by Schaefer and Fox models based on the data of several investigations[3]. The optimum fishing effort is ob-

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tained by the correlative curve between CPUE(catch per unit of effort) and fishing effort [4]

3 Results and discussion

3.1 Production analysis

Since 1980s, the yields of marine capture fisheries in Fujian Province have been rising year after year, from 548 000 t in 1986 to 1 737 700 t in 1996, with an increment rate of 12% per year. During this period, the fishing efforts put into the strait were also increased year after year; the engine power installed in fishing motor boats was increased from 597 200 kW in 1986 to 1 461 800 kW in 1996, and the increment rate per year was 9.4%; the gross tonnage was increased from 316 000 t to 537 000 t during this decade; the annual increment rate is 5.4%; the engine power of light - seiners fishing in this strait, however, was reduced from 36 363 kW to 28 486 kW, with annual decrement rate of 2.47%. Even so, their yields increased from 76 000 t to 88 300 t with an increment rate of 1.5% per year(table 1).

Table 1 Yield and fishing effort of marine capture fishery and light-seine fishery in Fujian Province (1986 ~ 1996)

year	marine capture fishery			light - seine	
	gross tonnage/t	marine engine power/kW	yield/t	main engine power/kW	yield/t
1986	316 052	597 218	548 125	36 363	75 997
1987	327 901	667 161	684 354	45 462	132 739
1988	352 692	718 110	696 276	51 734	98 681
1989	382 493	756 582	774 817	50 327	102 118
1990	404 351	842 396	829 691	45 323	76 397
1991	433 031	909 191	947 769	43 017	85 827
1992	455 662	1 065 807	1 042 233	33 322	80 522
1993	442 092	1 089 103	1 222 432	28 415	93 300
1994	463 160	1 184 963	1 443 566	27 318	82 276
1995	521 808	1 403 894	1 619 996	27 505	81 922
1996	537 367	1 461 791	1 737 682	28 486	88 344

It can be seen that the pressure on the fish stocks in the Taiwan Strait has increased year by year with the increase of fishing efforts in this strait per year. However, the proportion of installed power and yeilds of light - seine fishery to those of the total marine capture fisheries reduced year after year. The proportion of installed power reduced from 6% in 1986 to 1.9% in 1996 and the proportion of yields reduced from 13.9% in 1986 to 5.1% in 1996. Since the operation of light - seine needs higher technology and requires more labors and the economic value of pelagic fish is lower compared with other fisheries, the light - seine fishery is not further devoloped.

3.2 Relationship between environmental characteristics of fishing grounds and pelagic fish stocks

Based on the investigations[1,2], there are many upwelling regions in the Taiwan Strait, especially in the Minnan - Taiwan shallow shoal, where exits distinctive natural topographical condition and seasonal wind and tide influence. The waters may be brought by the upwelling from the subsurface to the surface layer, containing abundant nutrients and organisms . All that promotes plankton to flourish abundantly. At the same time, the driving force from the upwelling may adjust or alter the pattern of hydrology distributions and provide suitable hydrological conditions in the fishing ground, thus with a better environment a central fishing ground is formed for fish to feed, spawn and concentrate. There are abundant fish resources, especially pelagic fish, such as *Decapterus maruadsi* and *Pneumatophorus japonicus*, in the Taiwan Strait. The pelagic fish belong in *r* type of selective life history, with shorter life cycle, quicker generation replace, higher growth speed, earlier sexual mature and faster resources recovery. According to the assessment of several investigations on fish resources in the Taiwan Strait[3], the pelagic fish stocks in this strait (including both ends)are about 640 000 t with catchable yields of 330 000 t.

3.3 Influence of operational characteristics of light - seine on fish stocks and geologic environment

In the practice of light - seine, the pelagic fish are attracted by light to concentrate , and then were surrounded by the falling seine net. Shortly after that, the purse line is pursed and the ground rope is sinking and moving to the boat, restricted by pursing force. Its moving track is like a suspend curve. The pressure of the ground rope on the sea bottom is slight and its stay on the sea bottom is short (about 8 min)[5]. The impact on geologic environment is therefore relatively slight. Except for *Etrumeub micropus*, other pelagic fish are usually not attracted by light during their reproductive seasons[1,2]. The light - seine generally would not catch the reproductive individuals so that they have reproductive opportunities. Furthermore, the selectivity of light - seine to fish is relatively better that it seldom harms young fishes.

3.4 Analysis of optimum fishing effort

On the basis of sample data listed in table 2, a growing tendency of CPUE (t/kW) can be developed by the least squares method. The long term tendency of CPUE is:

$$CPUE = -3.26 + 1.206f - 0.060\,5f^2,$$

$$(R = 0.88,\ n = 11,\ F = 24.6 > F_{0.01} = 7.6)$$

Where f is fishing effort (×1 000 kW). The correlation coefficient is obviously different to zero, which indicates that the power of engines is one of the main factors affecting CPUE. The regression curve of the light - seine fishery is parabola - like(Fig. 1), which indicates that if other factors are not taken into account, the highest fishing efficiency power of sample light - seiners will be maintained at 9 967 kW. Since the CPUE in 1996 was below the highest point of the regression curve, the fishing effort should not be blindly increased in order to get better economic benifits.

Table 2 Fishing effort and catch per unit of effort (CPUE) on sample light - seiners(1986 ~ 1996)

year	yield/t	marine engine power/kW	CPUE/ $(t \cdot kW^{-1})$
1986	16 820	7 250	2.32
1987	20 025	8 010	2 50
1988	22 304	8 200	2.72
1989	28 762	9 850	2.92
1990	27 510	10 500	2.62
1991	28 386	11 586	2.45
1992	25 437	12 113	2.10
1993	28 505	13 258	2.15
1994	29 135	13 124	2.22
1995	30 247	13 151	2.30
1996	29 821	13 254	2.25

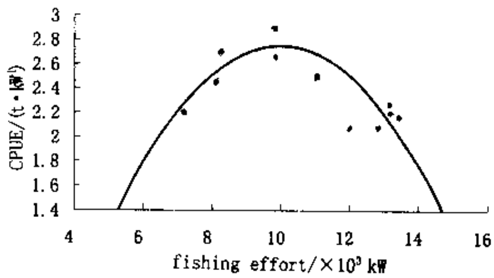

Fig. 1 Relation between CPUE and fishing effort on the sample boats

4 Conclusion

(1) The Taiwan Strait is favorable for pelagic fish to concentrate for its large quantity of plankton and stable hydrological conditions with much more upwelling. It does have some potentialities developed for its abundant pelagic fish.

(2) The light - seine catching of pelagic fish causes slight damages on the marine geologic environment and young fish stocks. The light - seine generally will not catch the reproductive individuals. Therefore, it is one of scientific and efficient methods to catch pelagic fishes.

(3) From the calculation of CPUE, with present fishing effort in the strait, the maximum economic yield could not be obtained. This is mainly relative to the economic value of pelagic fishes and operating technology of light - seine. Therefore, to develop light - seine continuously, the fishing equipment and technology and the process technique for pelagic fishes must be further developed so that their market price and fishing efficiency can be raised.