

7.18 Freshwater fish seed resources in Thailand

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ABSTRACT

Aquaculture in Thailand has developed considerably since the beginning of the century. At present, it has long-term potential for increasing fisheries production for both local consumption or export as well as contributing to national economy through earnings from high value shrimp and other fish species. Freshwater aquaculture has been practiced in Thailand for more than 80 years. At present, more than 50 freshwater aquatic animals have been cultured. Among these, 50 percent are indigenous and the rest have been imported and domesticated for a long time. The main cultured species are walking catfish (*Clarias sp.*), the hybrid catfish (*C. macrocephalus* x *C. gariepinus*), Thai silver barb (*Barbodes gonionotus*), snakeskin gourami (*Trichogaster pectoralis*), giant prawn (*Macrobrachium rosenbergii*), river catfish (*Pangasianodon hypophthalmus*), snakehead (*Channa striata*), common carp (*Cyprinus carpio*) and soft-shell turtle (*Trionyx sinensis*). Freshwater seed resources in Thailand come from two major sources: government and private hatcheries. Resources from the government sector include 31 inland fisheries research and development centres, 1 research institute and 27 inland fisheries stations. Most private hatcheries are found in surrounding provinces of the central part of Thailand such as Nakornpatom, Rachaburi, Phatumthane, Chachaengsoa, Samutprakan and Suphanburi. Government hatcheries were established for the purpose of supplying seed and also to demonstrate hatchery technologies. Interested farmers were given training and provided with broodstocks. The role of government hatcheries was to spur the cultivation of a species by supplying fry and fingerlings free or low cost. As private hatcheries developed, their role became provider of fry to small-holders for nursing or grow-out operations and to the government for stocking in public waters. Government hatcheries frequently concentrate on products that have broader social interest, such as broodstock, or on species that are unattractive to the private sector, such as indigenous species. These hatcheries produce fingerlings, provide some extension services and even undertake research. Since 2003, the Department of Fisheries (DOF) had implemented a programme on Good Aquaculture Practice (GAP). At the beginning of the programme, farmers and hatchery operators have to register their farms with the DOF. Farmers are required to use seed and post-larvae from hatcheries implementing GAP. Through this programme, the DOF is now able to record the number of hatcheries, their production areas and yearly production. In 2005, there are 4 673 private hatcheries, with a total area of 504 131.88 rai and yearly production of 35.9 billion fry/fingerling. Most hatcheries

apply the hormone-induced spawning technique, commonly used hormones are Lutenizing Hormone Releasing Hormone analog (LHRHa) and Human Chorionic Gonadotropin (HCG). Monosex tilapia seed are supplied to the market by hatcheries that use the sex reversal technique.

INTRODUCTION

Aquaculture in Thailand had developed considerably since the beginning of the century. Although freshwater aquaculture has been developed for a long time, coastal aquaculture is much more recent. Aquaculture contributes about 25 percent in volume and 45.5 percent in value of the total fisheries production in 2002. At present, it has long-term potential to increase fisheries production for both local consumption and export as well as to contribute to national economy through earnings from high value shrimp and fish species.

Aquaculture activities in Thailand can be divided in two categories, namely: freshwater aquaculture and coastal aquaculture. Freshwater aquaculture has been practiced in Thailand for more than 80 years. The development of freshwater aquaculture started in 1922 after the importation of Chinese carps for culture around Bangkok. However, the Department of Fisheries (DOF) had established the aquaculture promotion programme only in 1951. At present, more than 50 freshwater aquatic animals have been cultured.

Farming systems for freshwater aquaculture include use of ponds, paddy fields, cages and ditches. Most farms are densely located in water resources rich or irrigation areas. The central plain and coastal zones, including the vicinities of Metropolitan Bangkok, Samutprakarn, Suphanburi, Nakorn Pathom, Surat Thani, Chachoengsao and Chanthaburi are major provinces for aquaculture production. The number of fish farms in 2002 countrywide was 390 853 covering an area of approximately 131 500 ha. However, only 281 199 farms covering approximately 102 000 ha are producing. Most of these are pond farms. The number of registered farms in 2004 is more than 440 000 (Annex 1).

CULTURED SPECIES

More than 50 freshwater fish species had been cultured throughout the country. Among these, 50 percent are indigenous and the rest were imported and domesticated for a long time. Detailed freshwater aquaculture statistics by species are presented in Annex 2.

The main cultured species which contribute more than 50 percent in the total production are:

Walking catfish (*Clarias* sp.). The main cultured species is the walking catfish (*Clarias* sp.) with a production of 86 475 tonnes or 30 percent of the total production. The hybrid catfish (*Clarias macrocephalus* x *C. gariepinus*) is the most preferred species since it grows faster than the native ones. Recently, it has been reported that production per unit area of the hybrid catfish is decreasing and it was suggested that this may be due to the quality of the male African catfish which has been introduced to Thailand a long time back.

Tilapia (*Oreochromis niloticus*). The production of tilapia contributes around 29 percent (83 780 tonnes) to the total freshwater aquaculture production, second to the walking catfish. There is a trend towards standardization of size, feeds and production systems, some quality control, avoidance of off-flavors and marketing into supermarket chains. The main cultured types are hormonal sex-reversed tilapia, the Genetically Improved Farmed Tilapia or GIFT strain, Chitralada strain and Tabtim strain. This exotic species has now become very popular for freshwater aquaculture in Thailand, especially for cage culture.

Thai silver barb (*Barbodes gonionotus*). Thai silver carp or Java barb, indigenous to Thailand, ranks third in terms production and contributes around 15 percent to the total freshwater aquaculture production. The Neo-male broodstock has been produced in order to develop all female fish which has a higher yield than mix-sex culture. However, the all-female culture is not very well accepted by farmers.

Snakeskin gourami (*Trichogaster pectoralis*). Sepat siam is another indigenous species that contributes around 8 percent to the total freshwater aquaculture production. Production remains high though the culture technique is limited to extensive culture system.

Giant prawn (*Macrobrachium rosenbergii*). Freshwater giant prawn contributes around 5 percent to the total freshwater aquaculture production. The production is increasing gradually following the introduction of an improved strain, the CP strain.

River catfish (*Pangasianodon hypophthalmus*). The river catfish also contributes around 5 percent to the total freshwater aquaculture production. It is still very common in animal-fish integrated culture system in the central part of the country.

Other important freshwater species whose production is less than 5 percent of the total production are snakehead (*Channa striata*), common carp (*Cyprinus carpio*) and soft-shell turtle (*Trionyx sinensis*).

SEED RESOURCES SUPPLY

Freshwater aquaculture, as mentioned earlier, has long been established and practiced in Thailand and more than 50 species of fish and invertebrates are presently cultured. Freshwater culture consists of four main systems: pond culture, ditch culture, paddy field culture and cage culture. Total production from inland culture was 226 100 tonnes in 1998, valued at US\$271.4 million, an increase of 5.6 times in volume and 10.3 times in value from production data of 1981. The major production species were walking catfish, Nile tilapia, silver barb, snakeskin gourami, giant prawn and river catfish.

There are about 27 species of commercial species being cultivated under various types of systems ranging from super-intensive farming for commercial production to extensive culture, mainly for home consumption. There are 281 199 inland farms with a total cultivated area of 101 952 ha. Over 97 percent of the total area consists of ponds and paddy field-type culture systems. The remainder consists of dammed-up ditches, swampy areas and cage culture systems. The total Thai freshwater aquaculture production for the year 2003 was estimated to be 320 402 tonnes with the top five species being Nile tilapia, hybrid walking catfish, silver barb, freshwater prawn and snakeskin gourami. Production of tilapia in Thailand is moving away from green-water fertilized systems towards pellet-fed intensified systems. This may be a reflection of the available areas for aquaculture and increasing restriction on water availability and to some extent environmental requirements. The seed resources and supplies in Thailand come from two sources: (i) government hatcheries and (ii) private hatcheries.

Government hatcheries

There are 31 inland fisheries research and development centres, one research institute and 27 inland fisheries stations being operated and managed by the Department of Fisheries (DOF). Each station/centre/institute is located in each inland province and each fiscal year they have plans and budgets for producing fish seed and seed of other aquatic animals such as the freshwater prawn, frog, soft-shell turtle, *Moina*, *Chlorella*, etc. The location of government hatcheries is shown in Figure 7.18.1 and their production in 2005 are shown in Table 7.18.1, while production data for 2006 are shown in Table 7.18.2.

FIGURE 7.18.1
Map of Thailand showing the location of government hatcheries by provinces



Private hatcheries

Most private hatcheries are found in the surrounding provinces of the central part of Thailand such as Nakornpatom, Rachaburi, Phatumthane, Chachaengsoa, Samutprakan and Suphanburi; in other parts of Thailand, fish hatcheries are spread throughout the river side area. Since 2003, the DOF implemented a programme on Good Aquaculture Practice (GAP). Under this programme, farmers and hatchery operators have to register their farms/facilities with the DOF; farmers have to use seed and post-larvae

TABLE 7.18.1

2005 Production of fish fingerlings, freshwater post-larvae, frog larvae, *Moina* sp. and *Chlorella* sp. from fisheries stations and centres (in 1 000) (C = Inland Fisheries Research and Development Centre; S = Inland Fisheries Station)

No.	Station/Centre	Fish fry/ fingerlings	Prawn post-larvae	Frog post-larvae	<i>Moina</i> sp.	<i>Chlorella</i> sp.
1	Ching Mai (C)	1 509.804	0	0	6.5	0
2	Mae Hong Son (S)	913.890	0	0	0	0
3	Lamphun (S)	1088.200	0	1.6	0	0
4	Phayao (C)	647.066	0	0	0	0
5	Ching Rai (S)	3 381.854	0	0	11.5	0
6	Lampang (S)	1 774.617	0	0	0	0
7	Phitsanulok (C)	3 800.277	0	0	39.5	0
8	Sukhothai (S)	2 400.280	2	0	269	0
9	Phichit (C)	5807.200	0	0	0	0
10	Phetchabun (S)	2 882.505	0	0	0	0
11	Mae Hong Son (S)	913.890	0	0	0	0
12	Lamphun (S)	1088.200	0	1.6	0	0
13	Phayao (C)	647.066	0	0	0	0
14	Ching Rai (S)	3 381.854	0	0	11.5	0
15	Lampang (S)	1 774.617	0	0	0	0
16	Phitsanulok (C)	3 800.277	0	0	39.5	0
17	Sukhothai (S)	2 400.280	2	0	269	0
18	Phichit (C)	5807.200	0	0	0	0
19	Phetchabun (S)	2 882.505	0	0	0	0
20	Mae Hong Son (S)	913.890	0	0	0	0
21	Lamphun (S)	1088.200	0	1.6	0	0
22	Phayao (C)	647.066	0	0	0	0
23	Ching Rai (S)	3 381.854	0	0	11.5	0
24	Lampang (S)	1 774.617	0	0	0	0
25	Phitsanulok (C)	3 800.277	0	0	39.5	0
26	Phetchaburi (C)	2 222.509	0	18.35	0	0
27	Ratchaburi (S)	1 203.820	0	0	0	0
28	Chon Buri (C)	1 027.750	69.5	19.2	352.5	0
29	Samut Prakan(S)	2 355.070	0	0	0	0
30	Sa Kaeo (C)	1 335.525	0	0	0	0
31	Trat (S)	665.600	0	0	0	0
32	Rayong (C)	1813.153	97.4	0	0	0
33	Nakhonratchasima (C)	1268.650	0	0	140.5	0
34	Loei (S)	2037.900	0	0	0	0
35	Sakon Nakhon (C)	2048.930	395	0	0	0
36	Khon Kaen (C)	3163.280	0	0	0	0
37	Mukdahan (S)	2427.890	0	0	0	0
38	Kalasin (S)	5323.912	366.4	0	117	0
39	Amnat Charoen (S)	667.700	0	0	0	0
40	Udon Thani (C)	8114.831	0	0	336.5	0
41	Nongkhai (C)	3772.075	0	0	76.5	0
42	Roi Et (C)	3558.746	51	0	65	0
43	Ubon Ratchathani (C)	1381.098	0	0	3.5	0
44	Surin (C)	3797.728	0	0	58	0
45	Yasothon (C)	1716.686	0	0	27	0
46	Chaiyaphum (S)	3633.810	0	0	0	0
47	Si Sa Ket (S)	1211.016	0	0	15	0
48	Maha Sarakham (C)	1833.300	0	0	0	0
49	Nakhon Phanom (S)	1831.325	0	7.5	0	0
50	Narathiwat (S)	104.800	0	0	0	0
51	Songkhla (C)	1404.600	0	0	0	0
52	Yala (S)	955.255	0	0	0	0
53	Suratthani (C)	2481.860	195	0	34	0
54	NakhonSiThammarat(S)	2154.035	0	0	15	0
55	Phatthalung (C)	4910.600	523.1	0	0	0
56	Trang (C)	2762.821	625	0	0	0
57	Pattani (C)	2255.950	0	0	0	0
58	Satun (S)	528.000	22.2	0	0	0
Total		135 153.853	5 942.6	103.4	3 345.9	374

(PL) from GAP hatcheries to ensure that their operations follow the GAP guidelines. The DOF started to record the number of hatcheries, their production areas and yearly production. The number of private hatcheries, area and yearly production by provinces in Thailand in 2005 are shown in Table 7.18.3.

TABLE 7.18.2

Production plan for fish fry/fingerlings, prawn post-larvae, frog larvae, *Moina* sp and *Chlorella* sp.
(C = Inland Fisheries Research and Development Centre; S = Inland Fisheries Station)

No.	Stations/Centres	Aquatic animal larvae		<i>Moina</i> sp.		<i>Chlorella</i> sp.	
		# of fry	Value (Baht)	Volume (kg)	Value (Baht)	Volume (kg)	Value (Baht)
1	Chiangmai (C)	1 870 500	1 000				
2	Mae Hong Son (S)	961 150	120 000				
3	Lamphun (S)	745 000	126 000				
4	Phayao (C)	626 000	651 000				
5	Chiang Rai (S)	2 962 500	1 200 000				
6	Lampang (S)	1 400 000	265 000				
7	Phrae (C)	2 802 000	300 000				
8	Nan (S)	1 179 000	269 000				
9	Tak (C)	2 475 000	400 000				
10	Phichit 9 (C)	5 892 000	847 500				
11	Phetchabun (S)	3 090 000	430 000				
12	Phitsanulok (C)	3 332 000	714 400				
13	Sukhothai (S)	2 848 000	337 000	320	16 000		35
14	Nakhon Sawan (C)	3 300 000	450 000				
15	Kamphaeng Phet (S)	2 370 000	395 750	85	4 250		
16	Suphan Buri (C)	1 796 700	189 000				
17	Kanchanaburi (C)	1 541 000	300 400				
18	Lop Buri (C)	1 650 000	400 000				
19	Sing Buri (S)	1 700 000	255 000				
20	Phetchaburi (C)	3 500 000	350 000				
21	Ratchaburi (S)	2 070 000	319 500				
22	Chai Nat (C)	3 170 000	420 000	400	20 000		
23	Uthai Thani (S)	297 000	144 900				
24	Pathumthani (C)	2 113 250	528 850	1 023	51 150	500	20 000
25	Ang Thong (S)	2 851 000	504 000				
26	Saraburi (S)	2 200 000	440 000				
27	Chon Buri (C)	1 250 000	192 000	360	18 000		
28	Samut Prakan (S)	1 200 000	300 000				
29	Sa Kaeo (C)	1 750 000	200 000				
30	Trat (S)	801 500	178 950				
31	Rayong (C)	2 548 000	427 400				
32	Udon Thani (C)	7 546 000	1 975 000	500	25 000		
33	Sakon Nakhon (C)	3 430 000	500 000				
34	Nakhon Phanom (S)	1 683 400	1 240 280				
35	NongKhai (C)	2 820 000	673 850	123	6 150		
36	Loei (S)	2 390 000	500 000				
37	Ubon Ratchathani (C)	1 665 000	515 900				
38	Amnat Charoen(S)	1 197 600	134 760				
39	Surin (C)	2 436 000	454 200				
40	Si Sa Ket (S)	1 155 908	299 100	18	900		
41	Roi Et (C)	2 850 000	400 000				
42	Yasothon (C)	2 028 100	500 000				
43	Mukdahan (S)	1 660 000	350 000				
44	Khon Kaen (C)	4 590 000	699 000				
45	Maha Sarakham (C)	1 370 000	155 000				
46	Kalasin (S)	3 827 000	520 000				
47	Nakhonratchasima (C)	1 515 000	313 000	300	15 000		
48	Chaiyaphum (S)	2 811 500	600 050				
49	Surat Thani (C)	4 009 000	1 070 624	150	7 500		
50	Nakhon Si Thammarat (S)	2 580 000	484 000				
51	Trang (C)	2 846 000	462 600				
52	Satun (S)	700 000	100 000				
53	Songkhla (C)	625 720	195 220				
54	Yala (S)	1 445 000	201 100				
55	Pattani (C)	2 085 000	366 000				
56	Narathiwat (S)	250 000	50 000				
57	Phatthalung (C)	5 325 000	850 000				
58	Inland Aquaculture Research Institute	1 490 000	837 200				
Total		132 622 828	27 102 534	3 279	163 950	500	20 000

TABLE 7.18.3

Number of private hatcheries, area and yearly production by province in Thailand, 2005

No.	Province	No. of farms	Area (in rai)	Yearly production of fry/fingerlings
1	Bangkok	54	1 635.0000	188 258 000
2	Samutprakan	47	696.0000	1 803 792
3	Nonthaburi	6	207.0500	74 010 100
4	Pathumthani	42	425.9794	80 945 480
5	Ayutthaya	25	359.5312	225 395 005
6	Ang Thong	10	39.5000	12 232 000
7	Lop Buri	11	117.0000	1 522 053 000
8	Sing Buri	15	97.8750	48 970 000
9	Chai Nat	7	3.2500	10 004 100
10	Saraburi	25	129.6908	33 030 700
11	Chon Buri	694	2048.936	130 499 949 040
12	Rayong	157	268.0656	5 038 000 200
13	Chanthaburi	52	174.7627	1 181 343 510
14	Trat	42	212.3380	4 746 254 840
15	Chachoengsao	750	2185.4327	12 136 333 519
16	Prachin Buri	15	63.6000	23 152 000
17	Nakhon Nayok	70	423.7900	17 718 450
18	Sa Kaeo	3	5.2500	1 600 000
19	Nakhonratchasima	25	93.0500	55 742 000
20	Buriram	5	35.2500	3 100 000
21	Surin	86	467.8172	231 207 442
22	Si Sa Ket	37	27.5000	6 105 550
23	Ubon Ratchathani	202	600.2339	104 499 690
24	Yasothon	2	0	250
25	Chaiyaphum	194	280.2500	30 462 300
26	Amnat Charoen	60	898.6250	120 000 680
27	Nong Bua Lam Phu	29	247.6000	180 003 000
28	Khonkaen	81	223.4700	30 143 700
29	Udon Thani	22	147.7500	39 365 300
30	Loei	11	51.0000	7 370 000
31	Nong Khai	208	1390.4600	383 482 300
32	Maha Sarakham	267	2121.7221	1 743 589 700
33	Roi Et	293	802.4562	5 257 210 850
34	Kalasin	94	411.0000	11 303 100
35	Sakon Nakhon	12	73.5000	10 184 500
36	Nakhon Phanom	27	60.6000	7 855 700
37	Mukdahan	10	17.0000	8 001 550
38	Chiang Mai	16	786.915	22 475 000
39	Lamphun	1	0	2 000
40	Lampang	29	194.7112	3 037 100
41	Uttaradit	4	43.0000	13 001 000
42	Phrae	2	0.5000	2
43	Nan	2	6.0000	1 400 000
44	Phayao	70	306.1173	32 600 780
45	Mae Hong Son	6	8.5700	594 000
46	Nakhon Sawan	364	483016.0725	2 808 667 510
47	Uthai Thani	9	63.0000	10 069 500
48	Kamphaeng Phet	8	49.5000	162 000
49	Tak	7	17.5000	970 000
50	Sukhothai	282	301.9500	15 954 502
51	Phitsanulok	23	190.2500	79 927 000
52	Phichit	14	194.7500	102 555 000
53	Phetchabun	24	204.0000	52 085 000
54	Ratchaburi	28	352.0000	171 220 027
55	Suphan Buri	208	1798.8400	11 241 115 285
56	Nakhon Pathom	201	1075.9450	19 490 873 000
57	Samut Sakhon	73	1054.5000	73 061 760
58	Samut Songkhram	20	25.9610	103 264 000
59	Phetchaburi	24	124.5625	0
60	Prachuap Khiri Khan	171	213.8550	1 933 837 000
61	Nakhon Si Thammarat	354	1217.3150	10 679 830 193
62	Krabi	45	110.9000	1 476 568 000
63	Phangnga	166	474.4300	13 403 700 215
64	Phuket	442	1027.8581	18 327 273 051
65	Surat Thani	36	41.9030	85 410 000
66	Ranong	2	9.0000	0
67	Chumphon	7	159.0000	6 024 400 000
68	Songkhla	531	648.0200	7 446 459 520
69	Satun	183	285.2417	2 770 628 000
70	Trang	155	253.4870	21 370 982 980
71	Phatthalung	43	138.6710	187 097 000
72	Pattani	185	258.9810	1 106 018 030
73	Yala	9	2.1025	305 000
74	Narathiwat	28	47.6238	173 227 600
Total		7 462	511 745.3684	283 279 452 403

Rai: a unit of land measure equal to 1600 m² (about 0.4 acre)

SEED PRODUCTION FACILITIES AND SEED TECHNOLOGY

Aquaculture contributes around one fourth of the country's total fish production of 3.6 million tonnes. In 2003, aquaculture production was around 0.773 million tonnes and valued at US\$1.91 billion. Nile tilapia contributed the highest freshwater production of 97 209 tonnes but the giant freshwater prawn shared the highest contribution in terms of value. Detailed values on freshwater aquaculture production are presented in Annex 7.18.3.

Through years of scientific research, fish breeding and culture techniques have been developed and well established in Thailand leading to the success of mass breeding of many native fish and introduced species. Many of Thai breeders are specialized in specific groups of fish such as carp, catfish, tilapia, freshwater prawn, etc. The varieties of freshwater fish species in the Thai market are more than 50 species, of which 40 species are native to Thailand.

Seed and feed are the primary source of production costs in aquaculture. There is a need to research and develop ways of decreasing production costs and disseminating existing and new technologies. Development of low phosphorus feeds to reduce environmental impacts is also recommended. Since most of the feed ingredients are imported, especially fishmeal, the government has to reduce import tax. For feed management at different stages from broodstock to fry, most hatcheries use both live food and formulated feeds. The green-water technique is still used for larval rearing in some species as a direct food source through active uptake by the larvae and as indirect source of nutrients for fish larvae through the food chain. Many kinds of formulated feeds, such as micro-particulated diet, powder feeds, etc., are normally applied for rearing fish larvae.

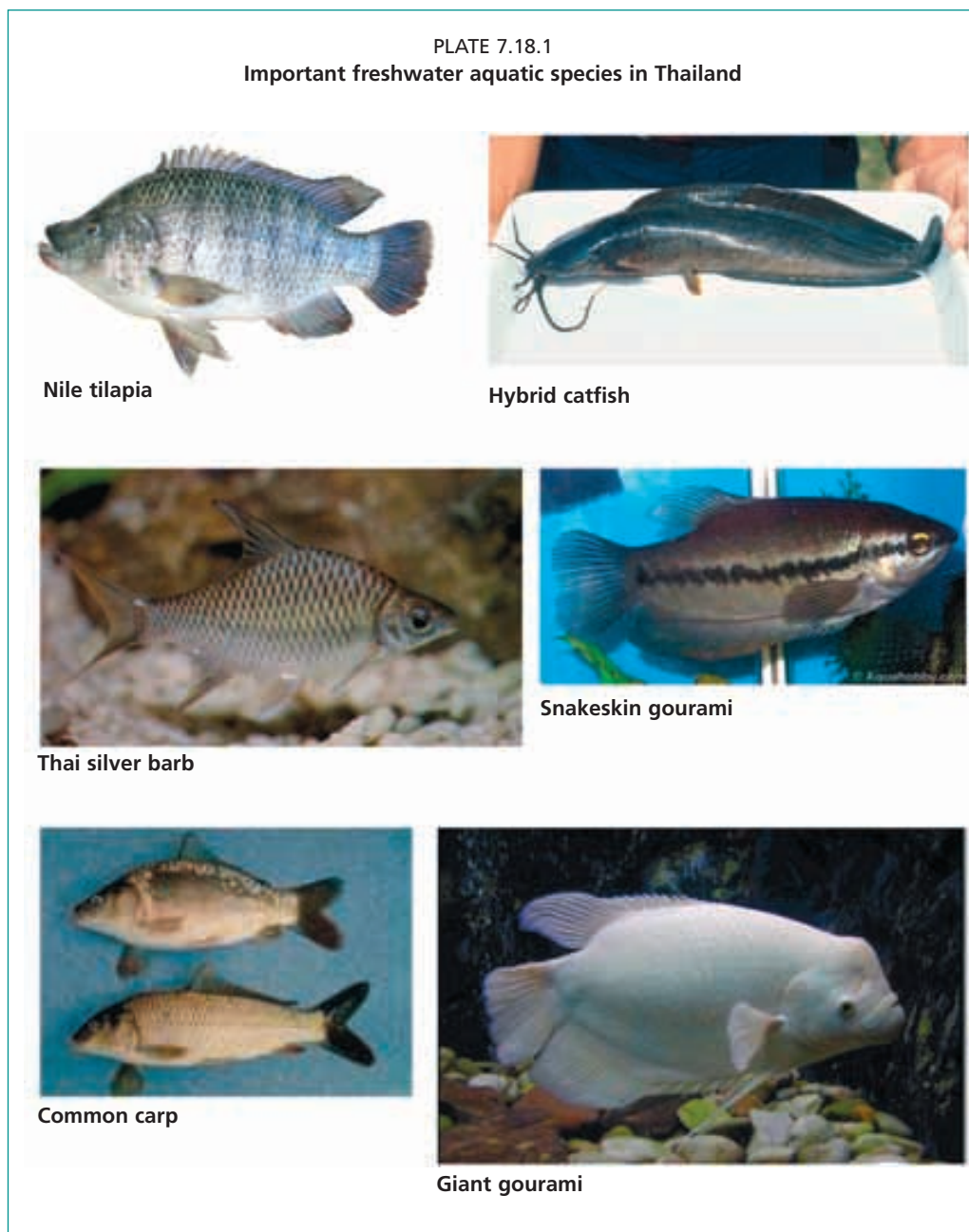
There are significant opportunities for research leading to improved seed quality/quantity, reproduction and early development of cultivated species. Successful research programmes in seed quality, reproduction and early development of cultivated species could enable year-round maturation and production, on demand, of gametes and fry of economically valuable species. It could also result in new markets for specialized broodstock, early life history stages and related technologies; and for technologically advanced delivery systems for chemical compounds to enhance reproductive performance.

SEED MANAGEMENT

Many hatcheries have good experiences in breeding specific fish species and freshwater fish are bred for commercial purpose. Some marine species were bred successfully only in government hatcheries. The size of the hatcheries depends on the species of fish, but in general, they are mostly small. The biggest private hatchery is Charoenpokaparn Company Ltd. (CP) which is famous for producing Ruby tilapia, freshwater prawn and seabass seed.

There are over 50 freshwater fish species, both native and exotic, found in the seed market. Local freshwater fish that can be bred are over 40 species belonging to the group of Cyprinidae, Siluiform, Bilontidae and Osphornamidae. Many species of introduced fish can also be bred successfully in Thailand such as tilapia, African sharp tooth catfish and Pacu fish. There is a current trend of increasing demand and supply for breeding exotic species or commercial species.

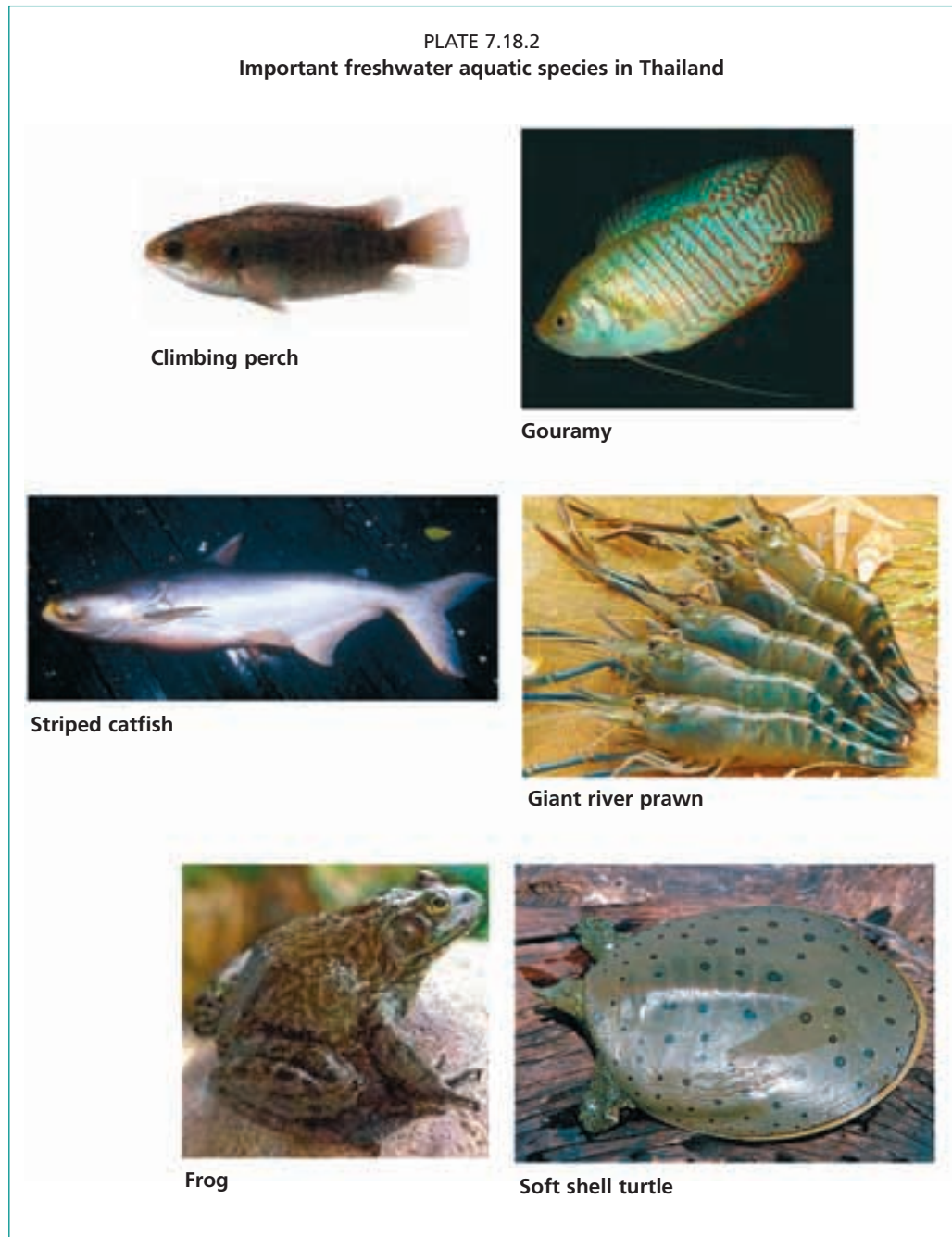
In addition to seed availability for certain species, the quality of seed is also an issue. Thailand have had a similar approach to the supply of seed, particularly for freshwater species such as carp, catfish, tilapia and freshwater prawn. Policy-makers recognize that the public sector, through government hatcheries, should provide seed if private hatcheries do not exist, or lack the capacity. Government hatcheries were established either for the whole country or for individual regions. Their purpose was to supply fry and fingerlings, and also to demonstrate hatchery technologies. Interested farmers were



given training and provided with broodstock. The role of government hatcheries was to spur the cultivation of a species by supplying fry and fingerlings free or low cost, but as private hatcheries developed their role changed to provide fry to small-holders or sell to the government for stocking in public water.

The government hatcheries frequently concentrate on products that have a broader social interest, such as broodstock, or on species that are unattractive to the private sector such as indigenous freshwater species. These hatcheries suffer from lack of funding, not enough budget for developing and are obliged to generate income by selling fish. However, they produce fingerlings, provide some extension and even undertake research.

The network of two fisheries research institutes and 58 fisheries centres/stations are mandated to produce seed for indigenous and commercial species but they also provide seed when seed demand is high. Generally, fish seed production is in private hands. In northeastern Thailand, most of the private fish farms are also involved in



seed production of carp, rohu and tilapia and where there are shortages, these may be more attributable to poor roads than to actual shortages. Government hatcheries often concentrate on broodstock and subsidized seed supply but because they have a non-profit goal, there are concerns over lack of funding. Also, there is a potential for corruption.

A common constraint in increasing seed availability is poor linkage between seed producers and growers. Seed producers may not see the need for a central clearing house to inform growers of their closest seed supplier. As a result growers often have to rely on fry traders. To encourage better linkages in the production chain, the Thai government through the DOF has developed information centres to connect seed producers and fish growers and organizes regular private/public seed markets. This requires databases by hatcheries and species. The policies are designed to improve the market system and match hatcheries with farmers.

SEED QUALITY

The Thai Government through the DOF are now supporting the fish seed business by setting up research projects on genetics and biodiversity of cultured species through the recently established Fish and Aquatic Animal Genetics Research Institute, located in Thunyaburi District, Phatomthane Province. The DOF also plays an important role in research and development of aquaculture and seed quality control. At present, there are 59 freshwater fisheries research and development institutes/centers/stations, 26 coastal fisheries research and development centers/stations and six aquatic animal genetics research and development centers/stations throughout the country. These institutes/centers/stations carry out both basic and applied aquaculture research, they also produce fry and fingerlings. These government hatcheries has also improved farmed species by encouraging collaborative research with universities.

Traditional activities have involved selection of desirable characteristics and improvement of the breeding stocks. Today, many breeders/hatcheries are encouraged by the potential profits and have improved breeding techniques and increased the production of various fish seed. Thailand has good climate, land, water resources and manpower suitable for the fish seed production. The Thai Government through the DOF are now supporting the business by transferring new technologies through training, provision of selected broodfish and technical services on GAP and food safety.

SEED MARKETING

Because of the large size of the country, prices of aquatic products, like any other product, vary greatly across regions. In addition, for each region, they change with seasons. The lack of complete data sets on market prices of different cultured species in Thailand makes it difficult to accurately determine the financial contribution of different cultured species to aquaculture and/or to the fisheries sector. A rough estimation of this contribution is made based on prices of some aquatic products which were provided by the Thailand Fisheries Information Network which collects information from different wholesale markets at different times since 1999. For each species, the price used for the estimation is the average price from different wholesale markets in different seasons. Data are presented in Table 7.18.4.

The distribution and marketing channels for the fish seed in Thailand are relatively well developed. The wholesaler plays an important role in linking up the producers/hatcheries and consumers. The hatcheries, specialized in breeding the commercial or favoured species and the farmers who focus on producing table fish (consumable

TABLE 7.18.4

Absolute and relative contribution of major cultured freshwater species to the value of the 2002 freshwater aquaculture in Thailand

Species	Product (1000 tonnes)	Price (Baht/tonne)	Value (million Baht)	% of aquaculture value
Striped snakehead	22	59 622.73	1 311.7	8.96
Walking catfish	68.4	33 805.56	2 312.3	15.8
Common climbing perch	5.4	36 462.96	196.9	1.35
Common silver barb	83.3	30 104.44	2 507.7	17.13
Nile tilapia	113.6	28 421.65	3 228.7	22.05
Common carp	18.6	27 360.22	508.9	3.48
Snake skin gourami	18.7	37 695.19	704.9	4.82
Catfish	12.1	17 223.14	208.4	1.42
Other fish	79.3	32 571.25	2 582.9	17.64
Giant freshwater prawn	4.8	122 916.67	590.0	4.03
Shrimps	1.4	234 928.57	328.9	2.25
Others	1.6	98 250.00	157.2	1.07
Total	429.2	n.s.	14 638.5	100

Source: Fisheries Statistics of Thailand 2002. Department of Fisheries

fish) usually sell their products to the wholesalers. The wholesalers could also buy the products (consumable fish) from farms in the region and distribute them to the local fish market or cold storages. Wholesalers usually sell fish seed to exporters or local retailers. Exporters would in turn sell fish seed to importers overseas, while retailers sell fish seed directly to local farmers. Hatcheries may also sell fish seed directly to farmers. Nowadays, contract farming is commonly practiced. Sometimes wholesalers have also ventured to running hatchery business to guarantee a stable supply of seed for their needs.

Thailand is regarded in the aquaculture business sector as one of the biggest exporter of fish seed. The country exports fish seed to over 20 countries worldwide with a value estimated at over US\$15 million annually. The main export markets of fish seed are India, Bangladesh, Myanmar, Lao PDR, Viet Nam, Malaysia, Indonesia and Taiwan Province of China.

SEED INDUSTRY

Subsistence freshwater aquaculture, as well as inland capture fisheries, both play vital roles in food security of rural people particularly in remote areas. In contrast, intensive freshwater aquaculture and brackishwater aquaculture generally involve higher financial investment and skilled labor forces. From 10 percent of total fisheries production in the Southeast Asia region, aquaculture's share increased from 12.9 percent in 1990 and 23.2 percent by 2004. Thailand have a long-established commercial aquaculture industry and were pioneers in brackishwater cultivation. Culture of freshwater fish and prawn, marine shrimp in Thailand was encouraged by governments for food security and foreign exchange. Seed industry was also developing according to the increasing demand of seed for commercial aquaculture.

Seed production and seed quality have also been the focus of policies and regulations. In Thailand, government hatcheries undertake research, training and technology dissemination. They also produce fingerlings. Some are destined for small-scale farmers and are subsidized and oriented to particular regions. They may also concentrate on particular species deemed to have potential commercial value. These government hatcheries have become a minority in production compared with private hatcheries, which have taken over the seed industry.

The government deliberately encouraged private hatcheries by providing incentives as soft loans or tax exemptions. They can be oriented to particular species, as *Tilapia* and *Macrobrachium*. The incentives may also be available to foreign investors. Such incentives have succeeded in increasing private hatchery production of seed. To improve seed quality from the private sector, regulations and inspections are used in Thailand. Monitoring and enforcement, however, is expensive; it also requires skilled personnel.

For the seed industry, there are also preferential credit for household farmers and large-scale farms. *Tilapia*, common carp and freshwater prawn are among the species whose cultivation is constrained by seed quality. *Tilapia* and *Macrobrachium* farming are also handicapped by seed shortages in some regions and season. A serious constraint for certain species is seed availability and quality. To increase seed availability other policies have been adopted. The government allows the import of equipments, material supplies and the employment of foreign technicians. To increase availability of seed and to lower the price of seed, the DOF have strict prohibitions on the export of broodstock. The government allows the export of fish seed to other countries and also imports from other countries. However, the seed has to pass strict quarantine and quality controls.

The private sector has a network of hatcheries and nurseries for their freshwater aquaculture that supplies fry and fingerlings preferred by farmers. Nursing farms also need to be developed. Fish seed production is highly segmented with farmers

specialized in breeding and production of larvae and young fry which are sold to others who grow them to a larger size.

Even more significant of Thailand's freshwater seed industry is the employment in freshwater fish farming. In 1992, Thailand's employment in freshwater aquaculture was estimated at 239 684. Since 1992, output of freshwater fish in Thailand has almost tripled, so employment would also have increased. A conservative estimate would suggest that at least 500 000 people are currently employed in freshwater aquaculture with 600 000 employed in total. Data on household income suggest that aquaculture was a lucrative activity. In 1992, except for carp culture, households earned on average more than US\$1 000 growing freshwater fish. Fresh water prawn farming was even more lucrative with household incomes approaching US\$12 000.

SUPPORT SERVICES

The DOF, under the Ministry of Agriculture and Cooperatives, plays an important role in aquaculture development planning and implementation in Thailand. These include aquaculture extension services and transfer of fish culture technologies. Administration of the DOF is divided into two parts: the central administrative and the regional administrative sections. The central administrative part includes five bureaus and nine divisions; whereas the regional administrative part includes 75 provincial fisheries offices. The organizations within DOF that share responsibility for aquaculture management and development include three bureaus (Inland Fisheries Research and Development Bureau, Coastal Fisheries Research and Development Bureau and Fisheries Development and Technology Transfer Bureau), three divisions (Aquatic Animal Genetics Research and Development Institute, Fishery Technological Development Division and Fish Inspection and Quality Control Division), 31 inland fisheries research and development centers, 15 coastal fisheries research and development centers and 75 provincial fisheries offices.

There are at least 16 universities around the country that offer aquaculture and related courses from diploma to post-graduate (e.g. PhD) degrees. These universities also carry out research on aquaculture and offer training courses on several aspects of aquaculture. New technologies have been transferred to farmers and private hatcheries through training and other mass media services such as radio/television broadcast, internet and websites, etc.

There are many educational institutes that provide courses on aquaculture or bioscience from vocational to university levels. The areas of aquaculture research and development are also established in both the academic field and within the DOF. All these research and development bodies need linkages, strengthening and budget support. The DOF's budgetary allocation for fisheries research steadily increased from 1992 to 1998 valued between 2 400 to 3 800 million Baht (US\$96-152 million). The private sectors dealing with aquaculture business should also play their roles in supporting research and extension works.

SEED CERTIFICATION

There have been great concerns in aquaculture products' quality worldwide. Recently, the DOF developed guidelines on aquaculture farm standardization to ensure that aquaculture products are safe and produced through farm-to-table approaches. These guidelines are presently on a voluntary basis but will become mandatory in the near future. At present, three guidelines are available as follows:

- Code of Conduct for Responsible Aquaculture (CoC) has been developed for the marine shrimp beginning from hatchery, farm, aquaculture business (feed, therapeutic agents and chemicals), product distributor and processor. The DOF audits and certifies hatcheries, farms, distributors and processing plants in order to issue the label CoC product.

- Good Aquaculture Practice (GAP) emphasizes an aquaculture product that is fresh, clean, free of therapeutic agents and chemicals and non-contaminated with disease. GAP is a fundamental practice to be implemented by farmers in order to achieve successful implementation of CoC in the future.
- Safety Level is only for freshwater aquaculture product used for domestic consumption.

The DOF targets 30 000 hatcheries and farms to be certified for CoC and GAP for the year 2004. Farms/hatcheries are regularly monitored for hygiene and GAP with emphasis on the use of feed and therapeutants. Therapeutants such as oxytetracycline, oxolinic acid, chloramphenicol and nitrofurans in raw materials are monitored by DOF laboratories. DOF officers randomly sample seed, feeds, water and end-products or prior to harvesting products at farms through analyses using HPLC, ELISA or LC/MS/MS techniques depending on the chemical substances involved.

The Inland Fisheries Research and Development Bureau is the main government institute providing support to the industry by transferring new technologies to farmers/hatchery operators through training, provision of selected broodfish and other technical services. The policy of the bureau is to present useful and up-to-date information in suitable form to farmers, hatcheries and other stakeholders involved in fish seed production. Another activity of the DOF is to create an accreditation scheme for hatcheries. The use of the scheme is to ensure that strict control is consistently exercised so that only high quality fish seed are produced and sold. Hatcheries need to have a dedicated warehouse with adequate breeding tank and nursing facilities, reservoir tank for water supplying, polluted water treatment system and footbaths at entrance to the farmgate, etc. Under the scheme, the bureau routinely (i) collects samples of water, fish seed and other aquatic animals produced from these hatcheries for laboratory examination for pathogens and (ii) restrict the use of drugs and chemicals. The bureau confirms the absence of certain kinds of pathogens, restricted use of chemicals and drugs by the hatcheries.

LEGAL AND POLICY FRAMEWORKS

Many legislation/regulations have been applied as management tools of the government in order to effectively manage and monitor the aquaculture industry in Thailand. These include:

- Fisheries Act 2490;
- DOF Regulation on the Application and Certification on Live Black Tiger Shrimp (*Penaeus monodon*) Exportation, BE. 2547;
- DOF Regulation on the Application and Certification on the Importation of Aquatic Animals for Broodstock, BE. 2547;
- Organic Aquaculture Standard;
- DOF Regulation on the Importation and Registration of Hatchery and Farms for Breeding and Genetic Improvement of Pacific White Shrimp (*Penaeus vannamei*);
- DOF Regulation on the Certification of Marine Shrimp Hatchery Performing the Code of Conduct Production;
- DOF Regulation on the Certification of Marine Shrimp Grow-out farm Performing the Code of Conduct Production;
- DOF Regulation on the Certification of Marine Shrimp Production with Good Aquaculture Practice BE. 2546;
- Animal Epidemic Act 2547/2499;
- Food Act 2542.

ECONOMICS

In Thailand, aquaculture makes an important contribution to the national GDP. In 2002, aquaculture accounted for 2.07 percent of the total GDP (Sugiyama, Staples and

Funge-Smith, 2004). Aquaculture also plays a substantial role in providing vital income generation opportunities to the people. In 2001, aquaculture offered full-time or part-time jobs to 80 704 households while capture fisheries offered employment to around 50 198 households.

The aquaculture industry generates many other related businesses. Among the important ones are fish seed, fish feed, chemicals suppliers, storage, processing, marketing, etc. Since fish seed is a key factor to the success of the aquaculture industry, seed production needs to be developed before expanding existing national aquaculture production plan.

INFORMATION OR KNOWLEDGE GAPS

The increasing importance of aquaculture strongly argues for government to give priority to developing clear, well-formulated, implementable and realistic national and local policies for aquaculture development, based on financial, social and environmental sustainability. As the private sector is the key to successful land sustainable aquaculture development, the views of the industry should be taken into account with respect to policy formulation, research and development.

Aquaculture in Thailand will retain its increasingly crucial function to maintain the importance of low-input aquaculture as a protein food supplier for domestic consumption as well as to develop a highly competitive, sustainable aquaculture industry in Thailand to meet consumer demand for cultivated aquatic foods and products that are of high quality, safe, competitively-priced and nutritious and are produced in an environmentally responsible manner with maximum opportunity for profitability in all sectors of the export industry.

FUTURE PROSPECTS AND RECOMMENDATIONS

Since capture fisheries are being harvested at or above their maximum sustainable yield, aquaculture is playing an increasing role as a protein food supplier to the world population. Thailand has proved to be a country of high potential and success in aquaculture for decades. The increasing contribution of aquaculture, in brackishwater or freshwater, has become a substantial part of the country's economic development. Further development of aquaculture is, therefore, of great national interest. A consensus has been developed that a dramatic increase in aquaculture is needed to supply both domestic and foreign growing aquatic food needs.

The continued growth and competitive position of the Thai aquaculture industry in the global market place will be directly related to the resources invested in research and technology development. The diversity of species cultured, seed quantity and quality and the production systems employed present added challenges for aquaculture's future research agenda.

An expanded research and technology development programme for aquaculture will offer significant benefits to both producers and consumers of aquatic products by enhancing production efficiency and quality of aquatic organisms cultivated for both food and non-food purposes. It will also help assure environmental compatibility of aquaculture systems, enhance understanding of biological systems and processes, lead to development of new or improved aquatic products and processes and contribute to conservation, enhancement, or utilization of important genetic resources.

There are opportunities to substantially improve production efficiency through research in the areas of genetics and seed quality development, i.e. improving traditional aquatic animals breeding, broodstock development; aquatic animal health, i.e. population health management, pathogen-free and disease-resistant broodstock; healthy reproduction and early-stage larvae development, i.e. year-round maturation and production and growth, development and nutrition, i.e. increased survival, faster growth rates, better feed conversion rates, improved environmental tolerances, etc.

There are also significant opportunities for research and technology development to improve the sustainability and environmental compatibility of aquaculture systems. Of primary concern is the protection and conservation of the nation's water resources. Beneficial results could include improved water utilization, reduced waste output from aquaculture systems, improved waste management, development of economically viable uses of waste byproducts and reduced costs of waste treatment. Additionally, new markets for innovative water re-use systems and waste management technologies should be developed.

The development of improved means to assure safety and quality of aquaculture products through innovative processing technologies and new product development represent important opportunities for aquaculture. Research can lead to new techniques to improve the freshness, color, flavor, texture, taste, nutritional characteristics and shelf-life of cultivated aquatic animals. Practical technologies can be developed to detect, assay and reduce toxins, contaminants and residues in aquacultural products. Development and adoption of uniform quality standards throughout the aquaculture industry and assurance of product safety and high quality will improve consumer confidence in domestically cultivated aquatic animals.

There is considerable pressure on aquaculture to reduce its reliance on feeds containing fish meal and also to increase the efficiency of its current usage of this resource. There is no doubt that the high value sector of aquaculture is growing and this sector is the most reliant on feeds containing fish meal and fish oil. Within the aquaculture sector, there is likely to be shifts in feeding and feed composition since the freshwater aquaculture sector has a greater opportunity to use non-marine sourced feed ingredients, particularly slaughterhouse wastes, brewery wastes and agricultural mill by-products.

There is a need for expanded and improved extension educational programmes, incorporation with industry and researchers, to communicate promising research results to demonstrate profitable technologies and to educate consumers and the public. There is also a need for other support services of the aquaculture industry including public information access and retrieval systems, aquatic plant and animal health services, marketing services, statistical and economic support services, etc.

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ANNEX 7.18.1

Number of farms, area under culture by type of culture and province (2002) - Area :ha

Province	Total			Pond			Paddy cum Fish			Ditch			Cage		
	No. of farm	Area	No. of farm	Area	No. of farm	Area	No. of farm	Area	No. of farm	Area	No. of farm	Area	No. of farm	Area	
Buri Ram	8 964	1 527	8 618	1 334	345	193	1	-	-	-	-	-	-	-	
Maha Sarakham	4 513	2 290	3 608	1 070	905	1 220	-	-	-	-	-	-	-	-	
Yasothon	4 970	975	4 503	537	436	416	30	22	1	-	-	-	-	-	
Roi et	1 808	472	1 464	265	344	207	-	-	-	-	-	-	-	-	
Loei	4 959	1 534	4 828	1 528	8	5	4	1	119	1	-	-	-	-	
Si Sa Ket	10 753	1 480	10 102	923	651	557	-	-	-	-	-	-	-	-	
Sakon Nakorn	1 496	427	1 482	414	14	12	-	-	-	-	-	-	-	-	
Surin	17 112	2 233	16 667	1 635	415	588	17	5	13	5	-	-	-	-	
Udon Thani	16 964	4 304	16 949	4 293	15	11	-	-	-	-	-	-	-	-	
Ubon Ratchathani	9 281	1 548	8 361	1 062	856	485	1	-	63	-	-	-	-	-	
Mukdahan	4 931	821	4 879	815	19	5	2	-	31	-	-	-	-	-	
Nong Bua Lum Phu	3 279	561	3 235	538	40	22	4	1	-	-	-	-	-	-	
Amnat Charoen	3 620	585	3 197	349	392	235	2	1	29	-	-	-	-	-	
Central Plain	52 494	58 646	45 475	38 478	4 025	18 257	2 691	1 900	303	11	-	-	-	-	
Bangkok Metropolis	1 082	2 372	1 044	2 311	15	56	8	6	15	-	-	-	-	-	
Kanchaburi	991	545	886	511	9	10	27	24	69	1	-	-	-	-	
Chantaburi	1 021	259	1 021	259	-	-	-	-	-	-	-	-	-	-	
Chachoengsao	4 455	5 466	3 585	1 320	677	4 009	192	137	1	-	-	-	-	-	
Chonburi	757	1 158	709	1 072	43	81	5	5	-	-	-	-	-	-	
Chai Nat	1 575	214	1 551	213	-	-	16	1	8	-	-	-	-	-	
Trat	537	131	537	131	-	-	-	-	-	-	-	-	-	-	
Nakhon Nayok	1 305	592	1 303	590	1	2	1	-	-	-	-	-	-	-	
Nakhon Pathom	5 117	4 947	5 061	4 921	1	3	54	23	1	-	-	-	-	-	
Nonthaburi	1 536	899	812	226	48	250	667	424	9	-	-	-	-	-	
Pathum Thani	2 078	1 527	1 083	1 306	-	-	247	219	28	2	-	-	-	-	
Prachuap Khiri Khan	1 359	315	312	1	3	-	-	-	-	-	-	-	-	-	
Prachin Buri	1 170	619	1 147	618	1	1	1	-	21	-	-	-	-	-	
Ayutthaya	3 374	2 138	3 018	1 821	3	9	327	307	26	1	-	-	-	-	
Phetchaburi	851	381	848	374	-	-	3	6	-	-	-	-	-	-	
Rayong	1 229	387	1 228	387	1	-	-	-	-	-	-	-	-	-	
Ratchaburi	2 687	3 069	2 573	2 948	23	39	91	83	-	-	-	-	-	-	
Lop Buri	1 204	352	1 170	320	20	24	10	7	4	-	-	-	-	-	
Samut Prakan	5 567	20 553	3 897	11 692	1 669	8 859	-	-	1	2	-	-	-	-	
Samut Somkharom	509	776	29	16	200	708	274	51	6	-	-	-	-	-	
Samut Sakhon	3 046	7 058	1 688	2 692	961	3 932	396	433	1	-	-	-	-	-	
Saraburi	1 237	491	1 173	441	10	3	54	47	-	-	-	-	-	-	
Sing Buri	1 128	236	1 040	218	3	5	78	13	7	-	-	-	-	-	
Suphan Buri	3 473	2 732	3 331	2 616	35	84	64	32	43	-	-	-	-	-	
Sa Kaeo	4 582	1 182	4 197	952	301	175	62	50	22	4	-	-	-	-	
Ang Thong	624	247	467	210	3	3	114	33	40	1	-	-	-	-	
Southern	26 611	2 599	25 845	2 466	29	8	706	123	31	2	-	-	-	-	
Krabi	746	99	746	99	-	-	-	-	-	-	-	-	-	-	
Chumphon	873	109	873	109	-	-	-	-	-	-	-	-	-	-	
Trang	2 350	223	2 349	221	1	1	-	-	-	-	-	-	-	-	
Nakhon Si Thammarat	3 049	384	2 911	326	12	6	120	53	-	-	-	-	-	-	
Yala	1 155	88	1 149	87	3	1	3	-	-	-	-	-	-	-	
Pattani	1 308	96	1 253	93	-	-	37	3	18	-	-	-	-	-	
Phangnga	557	87	556	82	-	-	556	1	5	-	-	-	-	-	
Phatthalung	4 668	369	4 377	336	-	-	285	33	6	-	-	-	-	-	
Phuket	235	26	234	26	-	-	-	-	-	-	-	-	-	-	
Narathiwat	1 947	155	1 929	153	-	-	18	2	-	-	-	-	-	-	
Ranong	467	37	466	37	-	-	-	-	-	-	-	-	-	-	
Songkhla	3 065	298	2 860	275	4	-	196	22	5	-	-	-	-	-	
Satun	845	76	843	75	1	-	1	1	-	-	-	-	-	-	
Surat Thani	5 352	553	5 299	548	8	-	43	3	2	-	-	-	-	-	

ANNEX 7.18.2**Quantity of main freshwater species produced**

Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total	177 759	200 663	229 120	239 760	226 772	252 553	270 974	279 654	294 465	320 402
Nile tilapia	59 397	76 054	90 416	91 112	73 427	76 460	82 363	84 480	83 780	97 209
Catfish, hybrid	34 170	44 120	47 711	60 759	57 466	72 289	76 000	77 905	86 475	90 248
Thai silver barb	24 133	27 432	37 615	35 100	38 951	41 289	46 276	42 152	44 242	48 844
Giant river prawn	10 124	7 792	8 000	7 856	4 764	8 494	9 917	13 310	15 393	35 102
Snakeskin gourami	16 993	16 714	14 200	17 230	17 214	21 989	21 577	22 519	24 179	13 590
Striped catfish	13 189	12 000	10 300	6 860	11 200	11 339	13 226	14 638	14 837	8 887
Common carp	3 419	3 556	3 887	4 209	7 093	5 811	5 539	4 773	5 046	6 861
Freshwater fishes	1 154	2 178	2 720	1 661	2 059	2 831	5 318	5 019	5 381	5 851
Striped snakehead	6 500	5 790	7 750	6 921	5 336	4 005	4 447	6 830	5 483	5 773
Roh labeo	2 899	1 481	2 590	2 736	1 876	1 704	1 172	1 595	2 125	1 960
Mrigal carp	444	478	680	670	1 620	1 285	1 057	798	985	1 543
Frogs	353	137	439	440	1 132	1 010	1 033	1 046	835	1 326
Climbing perch	1 944	949	1 189	910	763	760	470	403	519	1 049
Silver carp	2 059	654	402	1 032	565	481	438	202	202	581
Giant gourami	15	349	30	1 160	1 475	1 709	1 487	1 182	1 555	526
Soft-shell turtle	70	80	117	150	324	342	367	2 523	3 143	487
freshwater eel	<0.5	1	<0.5	12	16	539	38	38	25	240
Gouramis	58	259	374	349	93	97	169	154	165	220

ANNEX 7.18.3**Value of main freshwater fish species**

Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total	177 540.20	216 439.40	236 128.10	233 643.70	167 719.40	226 885.30	245 800.20	208 569.90	255 658.20	347 097.50
Giant river prawn	37 881.90	33 684.60	31 972.10	25 108.40	14 168.80	28 343.10	32 518.30	35 727.90	41 335.40	124 874.90
Nile tilapia	35 191.70	53 789.10	66 111.60	58 705.20	45 963.00	53 457.20	57 775.50	51 088.10	62 615.20	75 201.60
Catfish, hybrid	32 446.60	45 477.50	47 029.20	63 394.30	37 111.20	52 318.80	52 494.80	45 744.40	56 935.90	60 060.50
Thai silver barb	21 994.60	26 139.90	32 832.40	30 154.10	26 303.30	32 197.30	40 504.50	25 187.30	32 766.60	39 895.80
Snakeskin gourami	19 338.80	24 621.40	20 177.60	23 037.00	15 878.00	28 962.30	28 755.20	20 216.80	25 611.10	15 645.40
Striped snakehead	12 421.90	12 303.50	16 104.20	14 639.60	7 441.50	6 585.10	7 214.20	7 778.00	7 854.80	8 593.60
Common carp	3 273.80	4 363.40	4 313.10	4 192.10	5 655.90	5 190.60	4 801.10	3 301.10	3 828.80	6 183.50
Striped catfish	6 676.20	6 228.00	5 913.70	3 610.60	4 608.90	5 954.80	6 919.40	4 856.00	6 541.30	4 589.10
Soft-shell turtle	1 432.40	1 689.00	2 428.40	1 988.60	2 212.50	4 847.10	5 497.00	6 132.00	9 390.90	3 238.10
Freshwater fishes nei	544.70	3 030.10	3 875.70	1 360.30	1 351.60	2 032.50	3 610.70	4 269.80	2 629.30	2 668.40
Frogs	705.80	321.00	877.80	771.80	1 421.80	1 494.50	1 450.80	893.40	975.30	1 556.60
Roho labeo	1 935.50	1 569.40	2 155.40	2 292.40	984.30	1 165.70	786.70	992.60	1 301.10	1 382.00
Climbing perch	2 143.60	1 447.90	1 346.50	1 080.40	1 512.50	882.80	540.80	369.80	592.70	1 267.60
Mirigal carp	423.20	417.90	536.90	481.90	864.80	713.60	581.50	382.70	673.30	985.20
Giant gourami	41.40	894.70	74.90	2 358.70	1 936.10	2 485.50	2 119.70	1 490.20	2 471.70	553.40
Silver carp	1 088.10	462.00	378.60	468.30	305.20	254.40	230.00	139.80	134.80	401.80

