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Current Status of Transboundary Fish Diseases in Malaysia: Occurrence, Surveillance, Research and Training

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Introduction

Malaysia lies within 100° and 119° East longitudes, and 7° North latitude (Fig. 1). Neighbouring countries are Thailand to the north and Singapore to the south. The country consists of two land masses with a total area of 330,434 square kilometres: Peninsular Malaysia is located south of Thailand, while East Malaysia, comprising the states of Sabah and Sarawak, stretches along

Fig. 1. Map of Malaysia (Peninsular and East Malaysia)

the northern part of Borneo. The two land masses are separated by the South China Sea. Malaysia has a total coastline of 4,675 km, with 2,068 km for the Peninsula and about 2,607 km for East Malaysia. It is on a strategic location along Straits of Malacca and southern South China Sea.

The fisheries sector plays an important role in providing fish as a source of food and protein. It contributes about 1.54% of the GDP and provides direct employment to 84,496 fishermen and 22,108 fish culturists. Over the years, the industry has succeeded in achieving a steady production from its marine inshore fisheries amounting to an average of 1.06 million tons (Annual Fisheries Statistics, 1998, 1999, 2000, 2001).

In 2001, the fisheries sector produced RM 5.45 billion (Euro 1.25 billion) consisting of 1,408,308 metric tons (MT) of fish valued at RM 5.37 billion, and 338 million pieces of ornamental fish valued at RM 81 million. Statistically, the sector recorded an overall decrease in production by 3.12%, but an increased value of 0.06% compared to 2000 figures.

Production from marine capture fisheries yielded 1,231,289 MT with a value of RM 4.17 billion. Within the sector, the coastal fisheries remained the major contributor with a production of 1,063,363 MT valued at RM 3.66 billion. The aquaculture sector recorded a production of 177,019 MT, which constituted 12.6% of the total fish production valued at RM 1,206.59 million. The inland fisheries sector remained insignificant producing only 3,446 MT or 0.24% of the total fish production (Annual Fisheries Statistics, 1998, 1999, 2000, 2001). The lists of aquatic animal species traded live for food and other purposes are given in Appendices 1A-1F.

I. Current Status of Koi Herpesvirus Disease (KHVD) in the Production of Common Carp and Koi

I-1. Production of Common Carp and Koi

Malaysia has been the largest producer for ornamental fish. Almost 90 percent of these fish and aquatic plants have been exported to Singapore and Hong Kong, France, Germany, United Kingdom, Thailand, Indonesia, Holland, United States of America and the Philippines (Fisheries News, April 2002). At the same time Malaysia is importing koi carp from Japan, Indonesia, Singapore, Thailand, Hong Kong and Taiwan with shipments through the Kuala Lumpur International Airport (KLIA)(Tables 1a-1b). Besides koi, Malaysia has also other carps and the production for the major species are tabulated in Appendices 2-5. Appendix 6 shows carp fry production from government hatcheries. Table 1c shows the number of koi that had been exported through the Bayan Lepas International Airport (BLIA) in Penang. There are 14 big koi fish producers in Malaysia.

I-2. Koi Herpesvirus Disease (KHVD) of Common Carp and Koi

Among the koi diseases reported in Malaysia was cyprinid herpesvirus (CHV) in the early 1990s reported by the University Putra Malaysia (UPM) in Serdang, Selangor. The gross pathology observed were non-necrotizing, benign neoplasm on the skin with whitish, soft, warty lesions, epidermal echymotic haemorrhages and lordosis (Hassan *et al.,* 1995). The virus was able to multiply in BF-2 and BB cell lines. Monoclonal antibody and structural analyses were performed on this virus (Abdullah, 2004).

The Department of Fisheries (DOF) Malaysia had been alarmed by the koi herpesvirus disease (KHVD) which was reported in Indonesia in 2002. The government took immediate action to ban the importation of koi especially from Indonesia. Tables 1a-1b show there was no koi importation from Indonesia in 2003. Until today, there is no outbreak of koi herpesvirus (KHV) in Malaysia.

To confirm the matter, a survey was started in 2002 by UPM to screen for this virus with funding from the Ministry of Science and Environment. The area covered for the survey included Selangor and Perak and the survey is still going on. All samples were Malaysian hybrid of koi. Polymerase chain reaction techniques using koi herpesvirus (KHV) primers reported from Israel's cases had been used for this purpose and until now the results are negative (Abdullah, 2004).

Table 1a. Total importation of koi (pieces) via KLIA in 1998-2003

Country	1998	1999	2000	2001	2002	2003	2004 (Jan-May)
China	0	0	509	0	0	0	1, 000
Japan	21, 361	26, 358	23, 877	16, 563	20, 363	11, 735	5, 584
Indonesia	0	2, 796	0	1	727	0	0
Singapore	10	0	1, 111	360	48	0	0
Thailand	0	0	0	0	1, 425	4. 914	410
Taiwan	0	3, 248	5, 926	10, 124	6, 451	3, 576	40
Total	21, 371	32, 429	31, 423	27, 048	29, 014	20, 225	7, 034

Table 1b. Total importation of koi via BLIA in 1998-2003

Number of Pieces	1998	1999	2000	2001	2002	2003	2004 (Jan-May)
	5, 403	6, 696	6, 866	5, 309	4, 234	22, 022	1, 132
Exporting countries	HK, T, J	HK, T, J, S	HK, T, J, S	HK, T, J, S	T, J	HK, T, J	T, J

Table 1c. Total exportation of koi via BLIA in 2001-2003

Year	2001	2002	2003	2004(Jan-May)
Number of pieces	8, 351	20, 148	37, 711	12, 761
Importing countries	G, H, I, F, UK, HK, S, USA	G, H, UK, J, USA	G, H, I, UK, USA	G, H, HK, UK, USA

F – France **G** – Germany **H** – Holland **HK** – Hong Kong
I – Indonesia **J** – Japan **S** – Singapore **T** – Taiwan
UK – United Kingdom **USA** – United States of America

I-3. Production of Ornamental Fish

The total production of ornamental fish increased by 10.4% from 306,096,870 pieces in 2000 to 338,055,460 pieces in 2001. In terms of value, the increase was 12.6% from RM 71.95 million in 2000 to RM 81.03 million in 2001. Johor remains as the main producer of ornamental fish contributing 263,760, 236 pieces, which was 78% of the total production of ornamental fish in 2001. Table 2 shows the estimated total production of ornamental fish and its value for 1997-2001. Appendix 1 lists the common English, local and scientific names of the fishes which are found in Malaysia. Ornamental fish production for 2001 according to group follows:

Group	Number of pieces
1. Poecilids	102, 487, 656
2. Cyprinids/ Barbs/ Danio/ Goldfish/ Koi	97, 078, 229
3. Anabantids	39, 790, 903
4. Characins	23, 148, 553
5. Cichlid	19, 932, 165
6. Cyprinodontids	742, 130
7. Osteoglossids	33, 576
8. Callichthyids	318, 001
9. Cobitids	75, 035
10. Aquatic plants	45, 086, 359
11. Others	9, 362, 853
Total	**338, 055, 460**

Table 2. Estimated total production of ornamental fish and its value in 1997-2001

Year	Number of pieces	Value in RM million
2001	338, 055, 460	81.03
2000	306, 096, 870	71.98
1999	340, 439, 721	80.23
1998	324, 542, 970	70.40
1997	309, 093, 053	61.22

II. Current Status of Viral Diseases in the Production of Shrimps and Prawns

II-1. Production of Shrimps

a. Production of Tiger Shrimp (*Penaeus monodon*) and White Shrimp (*P. merguiensis*)

The shrimp industry consists of the capture and aquaculture sectors. From capture fisheries using push nets and trawlers, 77,465 MT of shrimp worth of RM 875.5 million (Euro 203 million) were harvested in 2001. This figure is expected to remain constant for the next decade as a result of the moratorium imposed on trawling in the coastal areas.

Shrimp aquaculture is fast growing and production figure in 2001 was 27,013 MT worth RM 937.5 million (Euro 175 million). Two species are cultured: tiger shrimp *Penaeus monodon* and the white shrimp *P. merguiensis*. Table 3 shows the estimated total production of shrimps (Saidin, 2003; Syed Omar, 2004).

Table 3. Estimated total production of cultured *Penaeus monodon* and *P. merguiensis* in 1998-2003

Year	Number of pieces	Value in RM million
2003	20, 000	N.A
2002	27, 000	N.A
2001	26, 351	744, 796
	662	*18,968*
2000	15, 893	490, 000
1999	11, 733	328, 093
	454	*214, 645*
1998	9, 685	283, 443
	150	*4, 429*

Note: Figures in italics refer to *P. merguiensis*; *value in thousands of Malaysian Ringgit

Pond culture technology developed rapidly in the early 1980s with the importation of postlarvae from Taiwan. Malaysia is blessed with abundant supply of tiger shrimp broodstocks in the coastal areas of Sabah and Sarawak. The development of captive maturation and breeding technology resulted to the mushrooming of private hatcheries. Currently, there are 160 shrimp hatcheries with more than 80% in West Malaysia producing about 8 billion postlarvae annually.

The outbreak of white spot virus disease in the mid-1990s had affected many farmers resulting in economic losses amounting to about USD25 million (Euro 21 million). Thus, the shrimp aquaculture technology evolved from open culture system to close system to combat disease problems, particularly white spot syndrome.

At present, there are 1,126 shrimp farms employing about 22,000 farmers. Twenty percent of these are big farms having more than 20 to a few hundred ponds. Small and medium farms have less than 10 ponds. The culture practice is intensive with high inputs that produce an annual average of 3.5 MT.

In 2001, Malaysia exported about 144,590 MT of fish and fishery products valued at RM1.35 billion which mainly came from the exported shrimp products. The biggest exports went to Italy and Japan.

There had been reports of *Litopenaeus vannamei* being cultured illegally in the state of Perak in 2003, but no official written documents had been submitted since the farmers were very uncooperative (Saidin, 2003; Syed Omar, 2004).

b. Production of Freshwater Prawn (*Macrobrachium rosenbergii*)

Macrobrachium rosenbergii has always been found in Malaysian rivers. The fry and culture production figures are shown in Table 4.

Table 4. Estimated total production of freshwater prawn, *Macrobrachium rosenbergii* in 1998-2001

Year	Fry production from government hatcheries	Production in tons	Value in RM '000
2001	5, 469, 470	2, 034	19, 964
2000	5, 625, 250	1, 338	32, 998
1999	6, 038, 874	653	15, 250
1998	5, 612, 600	281	6, 361

Spawners are obtained locally and postlarvae are produced by private and government hatcheries. Grow-out culture is carried out in earthen ponds. There has been no record of importation for the species.

II-2. Major Shrimp Diseases

A. White Spot Syndrome Virus (WSSV)

WSSV is one of the most devastating viruses to infect penaeid shrimp. First discovered in Taiwan in 1992, it has spread rapidly to most growing countries in Asia. In Malaysia, it was first reported in 1994 and had spread to affect 80% of farms by 1996. Many species of penaeid shrimps can be infected, as well as crabs, spiny lobsters, and fresh water prawn. A number of small aquatic arthropods can harbour the virus. Virulence studies have shown that WSSV isolates are extremely virulent, with cumulative mortalities reaching 100%. During the second half of 2003, WSSV had reduced the annual production to 20,000 MT, 15% of which was *Litopenaeus vannamei.*

a. Etiology

White spot syndrome virus, a double stranded DNA virus within a new group Nimaviridae.

b. Clinical Signs

The shrimp experience anorexia and lethargy having loose cuticle with numerous white spots (0.5-2 mm) on the inside surface of the carapace. Moribund shrimp showed pink to red discoloration.

B. Bacterial White Spot Syndrome (BWSS)

It affects *P. monodon* and was first reported in 1998 (Wang *et al.,* 1999, 2000).

a. Etiology

Bacillus subtilis has been suggested due to its association with the white spots.

b. Clinical Signs

Dull white spots on carapace and all over the body. The white spots are rounded but not dense. Shrimp exhibit delayed moulting and reduced growth.

C. Yellow Head Virus (YHV)

It affects *P. monodon*, *Acetes* spp. and other small shrimps. Tests that had been conducted, so far, gave negative results.

a. Etiology

YHV is a single stranded RNA, rod-shaped, enveloped, cytoplasmic virus likely related to members of family Coronaviridae.

b. Clinical Signs

The disease causes abrupt cessation of feeding. Shrimp aggregate at edges of pond or near surface. The hepatopancreas become discolored giving a yellowish appearance and shrimp generally becomes abnormally pale.

c. Significance

YHV has been reported in the absence of the classic yellowish cephalothorax. The clinical signs are not always present. Postlarvae (PL_{20-25}) and older shrimp are more susceptible where mortality can reach 100% within 3-5 days. It is believed that infection can be transmitted horizontally and vertically by shrimp having chronic sub-clinical infection.

II-3. Significant and Emerging Viral Diseases of *Macrobrachium rosenbergii*

There is no record of any viral disease in *M. rosenbergii*. From normal observation, the prawns in the ponds may exhibit necrotic shells at most.

III. Surveillance, Monitoring and Diagnosis of Diseases of Aquatic Animals

III-1. Responsible Facility and Personnel

The responsible or Competent Authority (CA), facilities, and their locations are as follows:

Fish Quarantine and Quality Control Division
Department of Fisheries Malaysia,
Ministry of Agriculture and Agro-base Industry,
8th & 9th Floor, Wisma Tani,
Jalan Sultan Salahuddin,
50628 Kuala Lumpur, Malaysia

The functions of this division are to:

- Conduct fish inspection and quarantine procedures on imported live fish
- Conduct regular inspection on health status and sanitary conditions of registered fish farms particularly those with fish for export market
- Conduct inspection of live fish at the point of exits prior to the issuance of Health Certificates
- Ensure fish which are controlled by CITES are imported with valid documents. All CITES fish can only be exported through the Kuala Lumpur International Airport (KLIA), Sepang
- Provide extension services in fish diagnosis and treatment

a. Location of Facilities

1. Fish Health Management and Quarantine Center
   Department of Fisheries Malaysia
   Jalan Pekeliling 4
   46000 KLIA Sepang
   Selangor

2. Fish Quarantine Center
   Jalan Batu Maung
   11960 Batu Maung
   Penang

3. Fish Health Management and Quarantine Center
   Bukit Kayu Hitam
   06050 Jitra
   Kedah

4. Fish Health Management and Quarantine Center
   Kompleks Sultan Abu Bakar
   Tanjung Kupang
   61560, Gelang Patah, Johore

5. Jabatan Perikanan Negeri Kelantan
   Tingkat 6, Wisma Persekutuan
   Jalan Bayam
   15628 Kota Baru, Kelantan

b. Responsible Persons

The following are the personnel who take care of the various Quarantine and Inspection Centers (QIC) in Peninsular Malaysia:

1. Mrs. Rosmawati Ghazali
2. Mr. Hamid Hassan
3. Mr. Nummeran Nordin
4. Mr. Salehudin Ismail
5. Mr. Khaidir Othman

No surveillance and monitoring for diseases of aquatic animals are conducted regularly or periodically by these agencies due to staff constraints. Whenever alerts of disease outbreaks are received, staff from QIC will inform the state director and the National Fish Health Research Centre (NaFisH) will be instructed to investigate the case with them.

III-2. Diagnostic Capabilities and Major Diseases of Aquatic Animals

a. Definition of Levels of Diagnosis

Level I: Diagnostic activity limited to observation of animal and the environment, and clinical examination (On Site or Field Diagnosis)

Level II: Diagnostic activity includes Parasitology, Bacteriology, Mycology, and Histopathology (Laboratory Diagnosis)

Level III: Diagnostic activity includes Virology, Electron microscopy, Molecular biology and Immunology (Laboratory Diagnosis)

All of the above-mentioned QICs have Level I capability for disease diagnosis. Table 5 lists the other fish health laboratories in Malaysia.

IV. Quarantine Services to Prevent Entry of Diseases of Aquatic Animals

IV-1. Responsible Agency and Personnel

For quarantine services, the same laboratories and agencies are involved as reported in section III-1. Level I and sometimes Level II of diagnosis are available in these stations.

IV-2. Procedures and Requirements for Importation

Malaysia is one of the countries which follows the Food and Agriculture Organization of the United Nations (FAO) procedures and techniques for

Table 5. Fish Health Laboratories (government, private, university-based, etc.) in Malaysia, their level of diagnostic capability, and contact information

No.	Fish Health Laboratory	Level of Diagnostic Capability	Status	Contact Information
1.	National Fish Health Research Centre,Fisheries Research Institute, 11960 Batu Maung, Penang	Level III	Government	Contact Informattion Tel.: 046263922 Fax: 045263977 e-mail: nafish@tm.net.my; ambigadevip@yahoo.com
2.	Freshwater Fisheries Research Centre, Malacca	Level II	Government	Tel.: 063172485 Fax: 063175705 e-mail:roslyffrc@hotmail.com
3.	National Prawn Fry Production and Research Centre, Kg. Pulau Sayak, Kedah	Level II	Government	Tel.: 044374021 Fax: 044374470 e-mail: pppbuk@po.jaring.my
4.	Marine Fish Research Centre, Tg. Demong, Terengganu	Level II	Government	Tel.: 096956778 Fax: 096958626 e-mail:hussin58@msn.com
5.	Brackishwater Aquaculture Research Centre, Gelang Patah, Johore	Level II	Government	Tel.: 075101202 Fax: 075103015 e-mail:pptap@po.jaring.my
6.	Fisheries Research Institute, Bintawa, Kuching Sarawak	Level II	Government	Tel.: 082-334144 Fax: 082-331281 e-mail: friswak@po.jaring.my
7.	Fisheries Research Institute, Likas, Kota Kinabalu, Sabah	Level II	Government	Tel.: 088-428416 Fax: 088-425890 e-mail: Ahemad.Sadi@sabah.gov.my
8.	Aquatic Animal Health Center, Faculty of Veterinary Medicine, University Putra Malaysia, 43400 UPM Serdang, Malaysia	Level III	University	e-mail: shariff@vet.upm.edu.my

fish quarantine. Quarantine measures are necessary to facilitate transboundary trade in live fish. This helps to minimize the risk of spreading infectious diseases. Appropriate infrastructure or facilities is important to ensure no possible escape of pathogen to other aquaculture establishments, the environment, or to any natural aquatic resources or systems.

a. Procedures for Importation

The following documents have to be provided:

1) Application Form, FQ1DOF;
2) Import Licence from Fisheries Development Board (LKIM);
3) Import Permit from DOF;
4) Health Certificate from the exporting country;
5) Details of species (common and scientific name, quantity, number of containers/ cartons/packages);
6) 2 copies of invoices;
7) Airway Bill;
8) Custom Form K; and
9) CITES Certificate, where applicable.

b. Quarantine Procedures (Import)

1) Importer/owner must have quarantine facilities approved by the CA;
2) Upon arrival, all consignment must be quarantined for specified duration;
3) Adequate samples of every species must be sent to the laboratory for observations;
4) Used water, packing materials, containers and other associated shipping materials must be disinfected/sterilised;
5) Treatment for infected fish until all fish is free of diseases should be done;
6) If treatment is not successful, the consignment should be destroyed;
7) If extended period of quarantine is necessary, approval from the CA should be obtained;
8) Any abnormality/mortality during quarantine should be recorded;
9) Dead animals should be buried or destroyed in an incinerator; and
10) Only fish certified as pathogen-free can be released.

c. Quarantine Area

The quarantine area or premise to hold live aquatic species should conform to certain requirements as stipulated by the CA. The following requirements must be followed or complied to by the owner, or the importer or exporter, in order that quarantine measures can be effectively undertaken:

1) The location of the approved quarantine premise is easily accessible to facilitate inspection by the CA;
2) The quarantine premises must be located in an area free of flood, and away from any other aquaculture establishments including recreational fish farms, food processing plants, and natural aquatic systems such as rivers, lakes, wetlands and reservoirs;

3) The quarantine room or area must have a clear signage;
4) The quarantine room or area must be used exclusively for quarantine purposes;
5) The quarantine room must be fully enclosed, and walls and floor must be impervious and sufficiently smooth to facilitate cleaning and disinfection. Windows, if installed must be sealed or screened against entry of insects. The door must be self-closing and fitted with insect screen or insect proof screen door;
6) The floor must be able to contain spilt water, and must facilitate complete drainage into a treatment tank or reservoir approved by the CA;
7) Used water must be treated before discharge;
8) Adequate facilities must be provided to disinfect all equipment used;
9) Facilities must be provided for staff and inspectors to wash their hands and foot wears prior to entering and leaving the quarantine room;
10) All tanks and associated equipment must be properly and clearly labelled for the purpose of inspection;
11) All tanks must provide good visibility to facilitate inspection;
12) The quarantine room must be sufficiently lighted to permit inspection;
13) All dead aquatic species must be temporarily kept in a separate freezer and properly labelled; and
14) The quarantine room must not be accessible to unauthorized persons.

d. Protocols for Introduction or Transfer

1) Any individual intending to introduce or transfer new live aquatic species for commercial purposes must obtain written approval from the CA.
2) Detailed information on the live aquatic species must be provided for risk analysis as follows:
   a. feeding habits and food organisms utilized
   b. reproductive pattern and strategy (when, where, how)
   c. competition with other species
   d. predation by or on other species
   e. migration routes and timing (if applicable)
   f. disease history
3) Once approval by the CA has been granted, only a small quantity (to be specified by CA) will be introduced.
   i) Upon arrival, the consignment has to be surrendered to CA for further risk analysis and monitoring.
   ii) If the results of the risk analysis and monitoring indicate no negative impact on the environment and living aquatic resources, further introduction may be allowed.
   iii) Once introduced, the importer or owner is responsible to submit written report on the progress of the culture to the CA as and when required.
   iv) No movement or transfer is allowed from the owner's premise without the approval of the CA.

e. Species Already Used in Aquaculture

This group includes, but is not restricted to, live aquatic species which is introduced or transferred in large quantities without permanent occupation of the ecosystem (maintained in tanks or in outside systems with no access to open waters). The following are standard procedures in handling these species:

Inspection and Certification

If continued movement from one country to another, or one area to another, is necessary to maintain the commercial enterprise, each shipment should include certification attesting to their pathogen- and disease-free status and should be inspected upon arrival for possible signs of pathogens by the CA. Quarantine measures may have to be carried out by the importer as and when required by the CA. Risk analysis may have to be carried out if the species is deemed to be susceptible to other diseases that may not be virulent in the country of origin.

Transport

The transport of live aquatic species should be done in such a manner as to avoid loss of water en-route to the importer or owner's premises. If water loss is inevitable en-route, consideration of use of sterile water or water sterilization should be considered.

Handling

All packing materials and water must be appropriately and adequately disinfected upon arrival at the owner or importer's premises and quarantine area.

Control

In order to control and contain any possible escape of pathogen, holding sites or quarantine area at the importer or owner's premises must be secured against any means of escape.

f. Species Imported Solely for Scientific Purposes

Any person or research organization intending to import any live aquatic species for research purposes must not do so without prior consultation with the CA.

The purpose of importation or introduction must be clearly stated.

Prior to importation or introduction of any live aquatic species for research purposes, the CA should be notified giving details of the species, its history, biology, potential for pathogenic infection, and any other scientific information deemed necessary for the purpose of risk analysis.

- Risk analysis should be carried out rigorously before permission is granted. Importation can be allowed once the necessary documentations are in order and the Competent Authority is satisfied that would be imported species pose no danger to other natural living aquatic resources.

- Upon arrival, the procedures as in item d. iii. shall be complied.
- The facilities in the laboratory or in any other premise where the research would be carried out should prevent any means of escape throughout the research activities.
- Regular monitoring by the CA needs to be carried out, especially on health management.
- All research findings should be made available to the CA.
- Disposals or transfers to any other premise or destination are not allowed without prior approval of the CA.

g. Legislation, Laws and Regulations

Under legislation, Malaysia has to abide by the Fisheries Act 1985 (Act 317) Amendment 1993, Custom Act 1967 and CITES Regulations. To date, there is no special provision in the Fisheries Act which covers the need to quarantine live fish to prevent disease outbreak. However, Section 40(1) and 40(2) of the Fisheries Act does provide some control of aquatic animal disease.

Section 40 – Control of Live Fish

(1) Any person who:

a) Imports into or exports out of Malaysia;
b) Transports from West Malaysia into the Federal Territory (FT) of Labuan, states of Sabah and Sarawak;
c) Transports from FT of Labuan or the state of Sabah and Sarawak into West Malaysia
d) Transports from FT of Labuan into the state of Sabah and Sarawak;
e) Transports from the state of Sabah into the FT of Labuan or the state of Sarawak; or
f) Transports from state of Sarawak into the FT of Labuan or State of Sabah.

Live fish without a permit or in breach of any condition in a permit issued by the Director General under this section shall be guilty of an offence.

(2) The Director General may impose such conditions as he thinks fit in the permit, including conditions concerning the state of cleanliness of the fish to be exported, imported or transported and measures to avoid the spread of communicable fish diseases, or to avoid the release into the natural environment of non-indigenous species of fish.

h. Import Prohibition

The following are prohibited for import by special directives from the Director General of Fisheries:

1) Tiger shrimp broodstock
2) Exotic white shrimp, *Litopenaeu vannamei* – fry and broodstock
3) All exotic species for research purposes, without written approval from the Director General of Fisheries
4) All species of piranhas

i. Export Prohibition

The following are prohibited for export by special directives from the Director General of Fisheries:

1. Tiger shrimp broodstock
2. All types of corals
3. Cockles (*Anadara granosa*) < 25mm in size
4. Grouper fry < 6in (15.24cm) in size

j. Penalties

Section 25(b) stipulates a penalty of not more than RM 20,000.00, or jail term not more than 2 years, or both.

IV-3. List of Quarantinable Diseases of Aquatic Animals

Following is the list of quarantinable diseases of aquatic animals:

a. Viral Diseases

- White spot syndrome virus (WSSV)
- Iridovirus
- Viral nervous necrosis (VNN)
- Taura syndrome virus (TSV)
- Yellow head virus (YHV)
- OIE listed diseases
- Koi herpesvirus (KHV)

b. Bacterial Diseases

- Septicemia and dropsy
- Vibriosis

c. Fungal Diseases

- None

d. Parasitic Diseases

- Cryptocaryosis

e. Other Diseases

- None

V. Research and Training of Fish Health Staff for Quarantine, Diagnosis, and Surveillance of Diseases of Aquatic Animals

a. Current Research Activities

- Determination of protective antigens against Cryptocaryoniasis in marine fish cultures, for future vaccine development
- Identification and diagnosis of fish viral pathogens
- Streptococcosis in tilapia cultured in cages

- Immunity of indigenous fish and shrimp to bacterial pathogens (*Vibrio alginolyticus* and *Flexibacter columnaris*) and protective ability of these bacterial immunogens
- Morphological, serological and molecular characterisation of pathogens and non-pathogenic ectoparasites (Monogenea) on cultured and wild fish
- Inventory of fish pathogens in local aquaculture
- Epidemiology, immune response and diagnosis of blood parasites
- Epidemiology of viral diseases in fish and shellfish: hatchery phase study
- Development of rapid diagnostic technologies for screening and control of commercially important shrimp pathogens
- Development of fish disease management system for species indigenous to local aquaculture
- Isolation of microbial pathogens and development of effective vaccines and immunostimulants for fish and shrimp cultures
- Development of a DNA vaccine against *Vibrio cholerae*
- Establishment of primer databank for rapid identification of local bacterial pathogens

b. Departments and Universities for Research of Aquatic Animal Diseases

i. Department of Fisheries, Malaysia
ii. University Putra Malaysia, Serdang, Selangor
iii. University of Malaya, Kuala Lumpur
iv. University Science, Penang
v. Kolej Universiti Sains dan Teknologi Malaysia, Trengganu
vi. Department of Veterinary, Malaysia
vii. Department of Environment
viii. Lembaga Kemajuan Ikan Malaysia (LKIM, or the Malaysian Fisheries Authority Board)

c. Training

Training for fish disease are conducted by the Department of Fisheries National Fish Health Research Centre (NaFish), Fisheries Research Institute, 11960, Batu Maung, Penang.

Fish Health staff in Malaysia are trained to detect clinical symptoms, and to conduct basic parasitology, bacteriology, water quality and basic techniques using rapid test kits in the field for quarantine, diagnosis and surveillance of aquatic animals. Research Officers are trained in the postgraduate level at various Universities (USM, UPM and UM). Short-term trainings at AAHRI and SEAFDEC have also been awarded to them.

Training on TEM, SEM, X-ray techniques, virology, immunology and molecular techniques are required to support the needs for research, surveillance, monitoring and diagnosis of fish diseases in the country.

The Department of Fisheries Malaysia is continuing its efforts to update the quarantine system with more infrastructure and capability build-up since there is increased activity in live fish movements from aquarium fish and

aquaculture industry within the country and throughout the world. Other proactive steps to be implemented include:

- Highly trained man-power inputs (fish disease diagnosticians, backed by services in virology, bacteriology, mycology, parasitology and water chemistry);
- Fish disease monitoring system (or surveillance) with legislation and enforcement;
- Epidemiology data base to facilitate early warning system; and
- Increased capability in fish diagnostics with R & D back-up.

However, the cooperation and commitment of the industry stake-holders are also expected so that a well accepted and an effective quarantine system can be operational. In any case, in order to ensure the responsibilities of farmers, culturists and hobbyists, the Department of Fisheries has drawn a number of code of practices for the sustainability of aquaculture and fisheries.

d. Major Publications in Aquatic Animal Diseases

The major publications (scientific papers, reports, and others) on viral diseases of fishes and shrimps in Malaysia from 1998 to 2003 (in English or in local language) are listed in the References marked with an asterisk (*).

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Appendix 1A. List of live aquatic animal species involved in transboundary movement: Freshwater food fish

Common Name	Scientific Name
Aruan, Ruan Haruan, Toman Paya - Striped Snakehead	*Channa striatus*
Baung - River catfish	*Mystus nemerus*
Belut - Eel	*Anguilla* sp.
Belut - Freshwater eel	*Monopterus albus*
Jelawat – Sultan Fish	*Leptobarbus hoevenii*
Kap Rumput - Grass Carp	*Ctenopharyngodon idellus*
Kap kepala besar - Big head carp	*Aristhicthys nobilis*
Katla- Catla	*Catla catla*
Kelah - Red Masheer	*Tor tambroides*
Keli Bunga - Walking catfish	*Clarias macrocephalus*
Keli Kayu - Walking catfish	*Clarius batrachus*
Ketutu – Marble goby	*Oxyleotris marmoratus*
Lampan Jawa - Javanese carp	*Puntius gonionotus*
Lampan Sungai - Tinfoil barb	*Puntius schwanenfeldii*
Lee Koh - Common carp	*Cyprinus carpio*
Patin - Striped catfish	*Pangasius sutchi*
Temoleh - Temoleh	*Probarbus jullieni*
Tilapia - Nile tilapia	*Oreochromis niloticus*
Tilapia Merah - Red tilapia	*Oreochromis* sp.
Toman – Red snake head	*Channa micropeltes*
Udang galah –Giant freshwater prawn	*Macrobrachium rosenbergii*
Udang gantung – Glass shrimp	*Macrobrachium lancestrei*

Appendix 1B. List of live aquatic animal species involved in transboundary movement: Freshwater ornamental fish

Common Name	Scientific Name
Silver bala shark	*Balantiocheilos melanopterus*
Clown barb	*Barbodes everetti*
Striped barb	*Barbodes fasciatus*
Six banded barb	*Barbodes hexazona*
T' spanner barb	*Barbodes lateristriga*
Black ruby barb	*Barbodes nigrofasciatus*
Five banded barb	*Barbodes pentazona*
Tinfoil barb	*Barbodes schewanenfeldii*

Appendix 1B. (continuation)

Common Name	Scientific Name
Tiger barb	*Barbodes tetrazona*
Pearl danio	*Brachydanio albolineatus*
Leopard danio	*Brachydanio Frankie*
Zebra danio	*Brachydanio rerio*
Longfin barb	*Capoeta arulius*
Checkered barb	*Capoeta oligolepis*
Cherry barb	*Capoeta titeya*
Goldfish	*Carrassius auratus*
Fancy carp	*Cyprinus carpio*
Giants danio	*Danio malabaricus*
Red tail black shark	*Epalzeorhynchos bicolor*
Rainbow shark	*Epalzeorhynchos frenatus*
Flying fox	*Epalzeorhynchos kalopterus*
Flying barb	*Esomus metallicus*
Red barb	*Hampala macrolepidota*
Black shark	*Labeo chrysophekadion*
Red-finned cigar shark	*Leptobarbs hoeveni*
Flower horn	*Cichlasoma rajah*
Apollo shark	*Luciosoma setigerum*
Black phantom tetra	*Megalomphodus megalopterus*
Red phantom tetra	*Megalomphodus sweglesi*
Red eye tetra	*Moenkhausia sanctaefilomenae*
Emperor tetra	*Nematobrycon palmeri*
Hard-lipped barb	*Osteochilus hasseltii*
Rosy barb	*Puntius conchonius*
Odessa barb	*Puntius conchonius hybrid*
Golden barb	*Puntius sachsi*
Redtail rasbora	*Rasbora borapetensis*
Red scissor tail rasbora	*Rasbora caudimaculata*
Emerald eye rasbora	*Rasbora dorsiocellata*
Blue striped rasbora	*Rasbora einthoveni*
Elegant rasbora	*Rasbora elegans*
Harlequin rasbora	*Rasbora heteramorpha*
Clown rasbora	*Rasbora kalochroma*
Spotted rasbora	*Rasbora maculate*

Appendix 1B. (continuation)

Common Name	Scientific Name
Red striped rasbora	*Rasbora pauciperforata*
Scissor tail rasbora	*Rasbora trilineatus*
Bittering	*Rhodeus ocellatus*
White cloud mountain	*Tanichthys albonubes*
Climbing perch	*Anabas testudineus*
Combtail gourami	*Belontia hasselti*
Local fighting fish	*Betta imbellis*
Mouthbrooding betta	*Betta pugnax*
Fighting fish	*Betta splendens*
Honey gourami	*Colisa chuna*
Thick lip gourami	*Colisa labiosa*
Dwarf gourami	*Colisa lalia*
Kissing gourami	*Helostoma temmincki*
Paradise fish	*Macropodus opercularis*
Giant gourami	*Osphronemus goramy*
Chocolate gourami	*Sphaerichthys osphromenoides*
Pearl gourami	*Trichogaster leeri*
Moonlight gourami	*Trichogaster microlepis*
Snake skin gourami	*Trichogaster pectoralis*
Three spot gourami	*Trichogaster trichopterus*
Croaking gourami	*Trichopsis vittatus*
Molly	*Poecillia latipinna*
Guppy	*Poecillia reticulate*
Blue lamp eye	*Pseudomugil gertrudae*
Swordtail	*Xiphophorus helleri*
Platy	*Xiphophorus maculatus*
Parrot platy	*Xiphophorus variatus*
Argentina bloodfin tetra	*Aphyocharax anisitsi*
White spot tetra	*Aphyocharax paraguayensis*
Blind Cave tetra	*Astyanax mexicanus*
Blue tetra	*Boehlkea fredcochui*
Flag dwarf cichlid	*Aequidens curviceps*

Appendix 1B. (continuation)

Common Name	Scientific Name
Keyhole cichlid	*Aequidens rivulatus*
Blue acara	*Aequidens maroni*
Green terror	*Aequidens pulcher*
Agassizi	*Apistogramma agassizi*
Umbrella dwarf cichlid	*Apistogramma borelli*
Ramirez	*Apistogramma ramirezi*
Oscar	*Astronotus ocellatus*
Freiberg's peacock	*Aulonocara jacobfreibergi*
Nyassae peacock	*Aulonocara nyassae*
Badis badis	*Badis badis*
Peacock cichlid	*Cichla ocellaris*
Chocolate cichlid	*Cichlasoma coryphaenoides*
Texas cichlid	*Cichlasoma cyanoguttatum*
Flag cichlid	*Cichlasoma festivun*
Managuense cichlid	*Cichlasoma managuense*
Firemouth	*Cichlasoma meeki*
Zebra cichlid	*Cichlasoma nigrofasciatun*
Severum cichlid	*Cichlasoma severum*
Flower horn	*Cichlasoma* spp.

Appendix 1C. List of live aquatic animal species involved in transboundary movement: Marine food fish

Common Name	Scientific Name
Aruan tasek - Black kingfish/Cobia	*Rachycentron canadum*
Bawal emas- Silver pomfret/Snubnose dart	*Trachinotus blochii*
Celoreng – Spottedsnapper	*Lutjanus erytroptherus*
Cupak - Longfin cavalla	*Carabgiodes ciliarius*
Gerong-gerong - Golden trevally	*Gnathanodon speciοus*
Jenahak - John's snapper, Golden snapper	*Lutjanus johni*
Kaci - Painted sweetlip	*Plectorhynchus pictus*
Kerapu bara – Coral trout	*Cephalopholis miniatus*
Kerapu bara – Leopard coral grouper	*Plectropomus leopardus*
Kerapu bara – Spotted coral grouper	*Plectropomus maculatus*
Mamin – Napoleon wrasse	*Cheilinus undulatus*
Kerapu lilin/lumpur - Malabar grouper	*Epinephelus malabaricus*
Kertang - King grouper	*Epinephelus lanceolatus*
Kerapu bunga – Greasy grouper	*Epinephelus coioides*
Kerapu - Six-banded grouper	*Epinephelus sexfasciatus*
Kerapu harimau - Brown marble grouper	*Epinephelus fuscoguttatus*
Kerapu tikus - Polka-dot grouper	*Cromileptis altivelis*
Merah - Malabar red snapper	*Lutjanus malabaricus*
Senangin- Fourfinger threadfin	*Eleautheronema tetradactylum*
Senangin Taiwan - Red drum	*Sciaenops ocellatus*
Siakap - Giant sea perch	*Lates calcarifer*
Siakap merah – Red snapper	*Lutjanus argentimaculatus*

Appendix 1D. List of live aquatic animal species involved in transboundary movement:Marine ornamental fish

Common Name	Scientific Name
Angel fish	Pomacanthidae
Butterfly fish	Chaetodontidae
Clown fish	*Amphiprion* spp.
Dottybacks	*Pseudochromis* spp.
Dragonets	Callionymidae
Goby	*Gobiosoma* spp.
Parrot fish	Labridae
Seahorses, Pipefishes	Syngnathidae
Soft and stony corals	–
Trigger fish	Balistidae

Appendix 1E. List of live aquatic animal species involved in transboundary movement: Molluscs

Common Name	Scientific Name
Siput metiah - Abalone	*Haliotis asinis*
Belangkas - Horse shoe crab	*Limulus polyphemus*
Kerang - Cockles	*Anadara granosa*
Kepah	–
Kupang (Siput sudu) - Green mussels	*Perna viridis*
Siput belitong	–
Siput retak seribu - carpet clam	*Paphia undulata*
Tiram - Rock Oyster	*Ostrea folium*
Flat oyster	*Crassostrea* sp.

Appendix 1F. List of live aquatic animal species involved in transboundary movement: Crustaceans

Common Name	Scientific Name
Udang galah - Malaysian giant freshwater prawn	*Macrobrachium rosenbergii*
Udang harimau - Giant black tiger shrimp	*Penaeus monodon*
Udang karang - Spiny lobster	*Panulirus polyhagus*
Udang putih - Red-legged banana/white shrimp	*Penaeus indicus*
Udang putih - Banana/white shrimp	*Penaeus merguiensis*
Ketam renjung - Swimming crab	*Portunus pelagicus*
Ketam nipah - Mud crab	*Scylla serrata*

Appendix 2. Estimated aquaculture production in 1998 of major carp species from freshwater culture systems and their estimated wholesale value (RM '000)

Species (RM '000)	Production in different culture (MT)					
	Freshwater ponds	Freshwater cages	Ex-mining pools	Cement tanks	Pen culture	Total
Javanese carp	1, 617 (8, 502)	7 (30)	147 (623)	5(21)	31 (153)	1,807 (9,329)
Common carp	896 (5, 834)	0 9(33)	102 (424)	0	0	997 (6, 258)
Grass carp	658 (3, 121)	0	246 (1,104)	0	5 (21)	917 (4, 279)
Big head carp	99 (3, 089)		772 (2, 037)	0	3 9	874 (2, 434)

Appendix 3. Estimated aquaculture production in 1999 of major carp species from freshwater culture systems and their estimated wholesale value (RM '000)

Species (RM '000)	Production in different culture (MT)					
	Freshwater ponds	Freshwater cages	Ex-mining pools	Cement tanks	Pen culture	Total
Javanese carp	1, 276 (6, 758)	7 (30)	147 (623)	5 (21)	31 (153)	1,788 (8,920)
Common carp	887 (6, 061)	0	102 (424)	0	0	1, 042 (6, 680)
Grass carp	813 (4, 031)	9 (32)	246 (1, 104)	0	5 (21)	1,454 (6, 842)
Big head carp	146 (484)	0	772 (2, 037)	0	3 (9)	1, 125 (2, 961)

Appendix 4. Estimated aquaculture production in 2000 of major carp species from freshwater culture systems and their estimated wholesale value (RM '000)

Species (RM '000)	Production in different culture (MT)					
	Freshwater ponds	Freshwater cages	Ex-mining pools	Cement tanks	Pen culture	Total
Javanese carp	1, 214 (6, 100)	39 (174)	396 (1, 604)	0		1, 678 (8, 003)
Common carp	757 (5, 119)	0.1 (0.4)	222 (925)	0		981 (6, 052)
Grass carp	970 (4, 449)	48 (190)	452 (2, 043)	0		1, 484 (6, 746)
Big head carp	127 (788)	1.4 (3.5)	1, 486 (3, 811)	0		1, 620 (4, 617)

Appendix 5. Estimated aquaculture production in 2001 of major carp species from freshwater culture systems and their estimated wholesale value (RM '000)

Species (RM '000)	Production in different culture (MT)					
	Freshwater ponds	Freshwater cages	Ex-mining pools	Cement tanks	Pen culture	Total
Javanese carp	833 (4, 351)	17 (77)	147 (645)	0 0	15 (65)	1, 013 (5, 138)
Common carp	777 (5, 355)	0.1 (0.7)	163 (657)	0	0	941 (6, 013)
Grass carp	642 (3, 418)	10 (54)	163 (823)	0	6 (28)	820 (4,324)
Big head carp	115 (386)	0	1, 074 (2, 663)	0	0.9 (2)	1, 190 (3, 052)

Appendix 6. Fry production from hatcheries for major carp species in Malaysia from 1998-2001

Year	Javanese carp	Common carp	River carp
2001	2, 748, 775	199, 229	0
2000	4, 423, 654	711, 814	1, 403, 696
1999	8, 507, 705	1, 753, 753	2, 876, 029
1998	7, 119 438	2, 341, 625	3, 203, 728