Aquisap, A.C., M.A. Carigma, P.B. Cariño, V.M.J. Castrillo, F.C. Gayanilo, Jr., M.E.S. Guzman, C.C. Janagap, J.L. Maclean, D. Pauly, E.T. Tech and R.M. Temprosa. 1996. Asian fisheries science: a profile, p. 457-488. *In* S.S. De Silva (ed.) Perspectives in Asian fisheries: a volume to commemorate the 10th anniversary of the Asian Fisheries Society. Asian Fisheries Society, Manila. 497 p. [An abridged version of the Asian Fisheries Science Special Publication No. 6, 1991].

Asian Fisheries Science: A Profile

A. C. Aquisap, M. A. Carigma, P. B. Cariño[1], V. M. J. Castrillo, F. C. Gayanilo, Jr, M. E. S. Guzman, C. C. Janagap, J. L. Maclean, D. Pauly, E. T. Tech and R. M. Temprosa
International Center for Living Aquatic Resources Management (ICLARM)
M.C.P.O. Box 2631
Makati, Metro Manila 0718
Philippines

Introduction

The men and women who make up the Asian Fisheries Science community constitute an extremely diverse group in terms of their social, cultural and educational background. Yet they should be considered as a single group with regard to aquatic resources, because nearly all their countries lie within the one (Indo-Pacific) faunal zone, stretching from northern Australia to China and from India (and eastern Africa) to Hawaii. Thus, marine scientists in these countries are studying the same species and in some cases the same migratory stocks. The inland aquatic fauna are not as similar, however.

Overlying the biological aspects are social and cultural values which give the Asian region a unique flavour that percolates through the fisheries sector as much as if not more than other sectors. Thus, socioeconomic issues have a regional character also.

Nearly all the countries of the region were colonized or greatly influenced by various Western countries. This is reflected in their different fisheries educational systems and in their approach to research.

Until recently, there were no mechanisms for most researchers to meet to discuss their work. There were regional meetings for a few high-level scientists and specialists. For the most part, however, cooperation and even conversation did not extend beyond national borders. The formation of the Asian Fisheries

---

Editor's Note: This article is an abridged version of the Asian Fisheries Society Special Publication No. 6 of 1991. In view of the importance to the industry of the subject material covered and its rarity in the literature, it was considered appropriate to include those findings here. Undertaking this type of survey and analysis is very time consuming, and often frustrating. The findings still shed much light on the personnel involved in research and development of the industry in Asia, as well as on their productivity and the limitations they encounter.

[1]Ms Cariño passed away in April 1993.

Society in 1984 has provided opportunities to develop the spirit of a regional community through the regular Asian Fisheries Forum, a journal and special projects and workshops to investigate regional issues.

In 1986, the Society began a project to investigate the nature of the Asian fisheries science community itself—a study of the Society's constituents. The primary objective of the study was to determine the academic and other characteristics of Asian fisheries scientists, as well as of their scientific output, to present a quantitative assessment of the status of Asian fisheries science. These results would form a basic tool for researchers, educators and administrators. The data would present a baseline of Asian fisheries science activities against which future directions and progress could be evaluated.

Background

Definitions

It is not easy to define "fisheries science". The subject matter includes elements of limnology, marine biology and oceanography as well as a broad range of socioeconomic, legal and technological subjects. It reaches into agriculture, biochemistry and medicine. Two widely used definitions follow.

"Fishery science is the application of scientific knowledge concerning fish populations to the problems of obtaining the optimum production of fishery products, whether stated in tons of factory material or in hours of angling pleasure" (Everhart, Eipper and Youngs 1975).

"The scientific study of the use of the living resources of the waters ... Part ... is concerned with the biological, physical and chemical aspects of the process of organic production; part, with the distribution of the resources; part, with the effect of fishing" (Royce 1972).

These two definitions of fisheries (or fishery) science have in common that they rightly stress use, production and populations rather than focusing on the fish.

In the preface to their textbook, Everhart, Eipper and Youngs (1975) note that "a strong foundation in mathematics, chemistry, biometrics and zoology is not enough. The fishery scientist must also understand the economics of natural resources, the sociological problems of Man, and be sensitive to all the different kinds of interrelated environmental problems". The authors then describe research in this broad area as being (1) of a background nature, e.g., surveys and inventories; (2) basic research, e.g., on fish behaviour; (3) applied research, e.g., using fish behaviour in raceway design; and (4) developmental, e.g., testing raceway designs, modelling. Thus, the authors blurred in their explanation the distinction made in their definition of fisheries science.

Literature

The lack of distinction between those scientists focusing on the organisms and those focusing on the populations—in aquaculture systems or in capture fisheries—is a feature that permeates the fisheries literature also.

"The literature of fisheries is associated with a broad diversity of journals, most of which do not use the word 'fisheries' in their titles" (Maclean 1988a). FAO's Aquatic Sciences and Fisheries Abstracts (ASFA) has monitored over 30,000 items annually in recent years, although the total number of relevant items produced globally could be at least 40,000 (Freeman 1988). Some 65% (potentially 26,000 items/year) deal with living resources (Needham 1982). The coverage of marine biology by the Institute for Scientific Information (ISI) included 23 journals that published 1945 articles in 1987. These included a number of the most important fisheries journals, which include both marine and freshwater topics. Articles in these journals were cited by 7780 articles in the "51 journals that most cited" the 23 ISI-covered journals in 1987 (Fuseler-McDowell 1989). The implication is that this core aquatic biology/fisheries-related literature consists of only around 8000 articles/year.

Two studies (Pauly 1984; Maclean et al. 1990) of citations to ICLARM contributions to the literature showed that only about 10% of all citations were reported in the ISI coverage. On this basis, the total annual literature related to aquatic biology/fisheries may be as much as 80,000 documents.

It is worth noting other aspects of the core literature, as derived by ISI, in aquatic sciences—if only for comparison with Asian data. A recent analysis of the ISI database (Schubert, Glanzel and Braun 1989) covering 1981–85 showed that in the field of marine and freshwater biology, 9403 papers in 22 journals covered by ISI were published. The top 22 countries, covering 92.5% of all articles, were listed, of which India was the only one from developing Asia. The Indian contribution was 251 papers (50/year) or 2.67% of the world total. The expected citation rate of these papers was 1.29 (times cited/year), but was only 0.78. The observed/expected proportion (0.60) was the lowest of the English-language countries represented.

The ISI analysis gave separate results for a further nine journals in the fisheries field. These journals published 5135 papers during 1981–85. Eight major countries were represented, covering 91.7% of the literature. Asian developing countries were among the other 63 countries making up the remaining 8.3%.

The low citation rates of Indian papers were observed by Arunachalam (1979) who examined 1977 data from SCI files. He found that papers in Indian journals were rarely cited, and that almost all the citations were in Indian journals, i.e., that "the cognitive structure of Indian science is to a large extent a closed system". A contributing factor to this insular nature was that references cited by Indian authors were older than those by authors in other countries, suggesting a lack of relevance of many Indian contributions.

Arunachalam and Markanday (1981) compared India with three other "middle-level" countries from the point of view of scientific productivity: Australia, Canada and Israel. They noted that the insular effect observed above for India was a phenomenon of all four countries. However, a large percentage of the better-cited Canadian and Australian papers were published overseas, i.e., the insular effect was much less than in India or Israel.

Garfield (1983) observed that not only was India the major developing country in terms of numbers of articles in the database, but also that other Asian countries were insignificant in comparison. Those mentioned were Malaysia, Singapore, Thailand and the Philippines. India was said to produce half of all developing-country scientific literature.

Again, based on ISI data, several authors have commented recently on the scientific output of various Asian countries. Of the ASEAN countries, it was reported that "their contribution to worldwide enterprise of generating new knowledge in the sciences is ... meagre" (Arunachalam and Garg 1986). A study of scientific productivity and citation analysis in the Philippines using 1976–78 data concluded that scientific output there was "the wretched product of a wretched scientific effort" (Calleja 1980). Thailand was producing more scientific publications than other ASEAN countries, according to 1981 ISI data, as a "hopeful" developing country (Yuthavong 1983).

It must be remembered that the coverage of developing-country literature by the ISI database is extremely limited, and while some authors contend that the literature not covered by ISI is of minor significance only, there is growing evidence that this is not the case. A critique is given by Davis and Eisemon (1989), who examined the scientific literature of four newly industrialized countries (NICs) of Asia—Malaysia, Singapore, South Korea and Taiwan. Among their findings was that often the same authors contribute to both the "core" literature (of ISI) and to the "peripheral" literature. Perhaps then we are not seeing core and peripheral science but two different markets.

Some support for the "different market" concept comes from a recent study by Dizon (1991) on citations to two Philippine scientific journals (*Kalikasan* and the *Fisheries Research Journal of the Philippines* (*FRJP*)). Her extensive manual search for citations to the journals, covering nearly 2500 institutional publications and theses, showed that about half of all articles in the two journals had been cited (63% for *FRJP* and 44% for *Kalikasan*). This is similar to the citation pattern of fisheries-related (Western) journals in the ISI database: approximately half have been cited at least once (Schubert, Glanzel and Braun 1987) and to journal articles by ICLARM, of which 47% have been cited (Maclean et al. 1990).

Productivity

One consequence of not being able to define the amount of literature produced by fisheries scientists due to its broad coverage or absence of proper database coverage is the difficulty in comparing the productivity of scientists in different countries.

Nevertheless, productivity, in terms of number of documents produced per scientist, institution or country, is a measure often used as an index of excellence. Much has been written on the subject (e.g., see Knorr et al. 1979).

In fisheries, the number of primary literature and conference papers per researcher in 28 developing-country institutions was found to be close to that of researchers in developed countries (Morgan and Hopkins 1986).

In general, the number of scientists per capita shows a correlation with the third power of GNP (gross national product) per capita. A graph of this relationship in *Nature* (1981) showed that one Asian country, India, was far removed from the trend, having a much higher ratio of scientists to GNP. There were two interpretations: either such countries are more effective in creating scientists or the scientists are less effective in creating wealth.

In a brief review of literature on fisheries in the Indo-Pacific area, which embraces most of Asia, scientific articles were found to comprise only 19% of the literature output (Chua and Maclean 1988). The bulk of the literature consists of proceedings and reports (56%)..The database used was the Aquatic Sciences and Fisheries Abstracts. It showed that India was by far the highest contributor, as noted above for general science. The review also pointed out that much of the literature was on transfer of technology, which is not the main role of scientists.

Size of the Asian fisheries scientific community

How many researchers, managers or administrators would call themselves fisheries scientists? Over 200 institutions in Asia offer fisheries education and training, and many graduates take up nonrelated employment due to the limited opportunities in the fisheries field (Asian Fisheries Society 1988). There are about 11,000 tertiary students of fisheries in institutions in the major Asian countries (Maclean 1988b); in 1983, there were some 15,600 scientific personnel in the various educational, research and management organizations (Chua 1986). The available data shows that higher degree holders, those who would be expected to be researchers and authors, range from 4% to over 30% of the technical personnel in these organizations (excluding China, for which there is no data), the average being 23%. On this basis there would have been about 3600 fisheries scientists in the Asian region, including China, in 1983. The number for Southeast Asia using this proportion is 980, roughly in agreement with the 1982 estimate of "no more than 1000" in 1982 (Maclean 1982). Nearly 86% of the Asian Fisheries Society membership consists of higher (than Bachelor) degree holders. The number of Asian members in 1991 was 1679; they perhaps represent 47% of the total Asian fisheries scientific community, although the community has doubtless grown since 1983 when the data of Chua (1986) was collected.

Languages of the Asian fisheries scientific community

The language problem in agriculture was first addressed internationally in a 1983 workshop on copublishing (i.e., giving free rights to a second agency to reproduce publications in another language) sponsored by the International Rice Research Institute (IRRI) and IDRC. An international network to facilitate such translations resulted from the workshop. However, the only fisheries project in Asia that included translation as a major component was the SAFIS (Southeast Asian Fisheries Information Service) project run by the Southeast Asian Fisheries Development Center (SEAFDEC) from 1982 to 1986 (SEAFDEC 1985) in which a number of extension manuals were translated into or from one or more languages of the region, including English.

An examination of 884 articles worldwide dealing with the naming of fish revealed that English was the dominant medium, but there was strong national language use in the periodical literature on both local and international fisheries issues (Baldauf and Jernudd 1983).

For the four NICs—Malaysia, Singapore, South Korea and Taiwan—Davis and Eisemon (1989) found that in the literature not covered by ISI, English was used exclusively in Singapore; in 7–8 out of ten scientific publications in Malaysia and Taiwan; but only in 43% of publications in Korea, where the Korean language dominates the literature.

In a bibliography of Southeast Asian fisheries literature (Sarria 1982), a sample of 931 articles from or concerning five countries showed that the vast majority of scientific communication in Thailand and Indonesia was in the national language; few articles were published in English. Some 25% of Malaysian articles were in the national language, in agreement with Davis and Eisemon (1989). The data, shown in Table 1, also indicates the proportion of articles that, according to title or abstract, were concerned directly with issues in the publishing country. The proportions are all very high and perhaps justify the use of national languages to some extent. However, the danger is that scientists may not read scientific communications in other languages, especially English, and become more and more isolated from progress in other countries.

Bahasa Indonesia has been the only official Indonesian language since independence in 1945, but while Bahasa Malaysia is similarly the only official language in that country, English continues side by side with the national language in official documents and international conferences (Nababan 1985). In recent years the use of Bahasa Malaysia in tertiary education has increased.

Pilipino (Tagalog-based language) is the main oral language of the Philippine government. Yet practically all government documents are in English. In education, although there has been government requirement to use Pilipino in all but science and mathematics since 1974, little has eventuated (Sibayan 1985). Since the 1986 revolution, there has been a call to use Pilipino in tertiary education, but again this has progressed little.

Table 1. Characteristics of Southeast Asian fisheries literature

Publishing country	*No. articles*	*Articles in English (%)*	*Articles dealing with publishing country %*
Philippines	360	100	94
Thailand	190	17	96
Indonesia	317	9	91
Malaysia	57	75	116*
Singapore	7	100	157*

(from Sarria 1982)

*Articles published in other countries about Malaysia and Singapore, combined with local articles on the two countries, exceeded the number of articles published locally

N = 931 (data analyzed by one of the authors in support of the present study)

In Thailand, the use of English may be decreasing. The *Thai Fisheries Gazette*, which until recently featured articles in English as well as in Thai, is now virtually all in Thai.

Methodology

The sample of the Asian fisheries science community chosen was the membership of the Asian Fisheries Society. There is no other convenient, up-to-date listing. It was assumed that persons attracted to the Society would be representative of the community. No subsampling was attempted. It was intended to include all the Society membership.

Most of the relevant characteristics of the Asian fisheries scientists are contained in their curricula vitae, which are generally submitted together with Society membership application forms. Over 700 applications were on hand, forming a broad cross-section, from students to senior scientists.

A supplementary questionnaire was sent out to each member, requesting additional details on information sources, needs and updating of publication lists, etc., from their original application forms. The questionnaires were sent out in mid-1987.

Data on publications was entered into a microcomputer using UNESCO's CDS/ISIS software. Other data was stored and tabulated using a dBase software.

Demography

There were 436 acceptably completed questionnaires.

Nationality

Filipinos made up the largest national group in the sample, 24% of the total. Indian scientists were next, 22%. Other nationalities comprised 6% or less (Table 2).

Non-Asian scientists comprised 18%. On the assumption that these people were working on fisheries and/or related aspects relevant to Asia, they were included in some later analyses, but were separated for some calculations. It is of interest that Society membership is virtually worldwide.

Age

The mean age of respondents, 37 years, indicates that membership is young—almost 75% are under 45 years, although only 2–5% are under 25 years (Table 3).

Gender

Males made up 81% (352) of the sample.

Table 2. Country of nationality of respondents

	Respondents			*Respondents*	
	No.	*%*		*No.*	*%*
Australia	16	4	Kuwait	3	<1
Austria	1	<1	Lebanon	1	<1
Bahrain	1	<1	Malaysia	25	6
Bangladesh	7	2	Nepal	1	<1
Brazil	1	<1	Netherlands	1	<1
Burma (Myanmar)	1	<1	New Zealand	1	<1
Canada	6	1	Nigeria	1	<1
Chile	1	<1	Pakistan	5	<1
China	15	4	Panama	1	<1
Finland	1	<1	Papua New Guinea	1	<1
France	2	<1	Philippines	106	24
Germany	1	<1	Poland	1	<1
Hong Kong	1	<1	Saudi Arabia	2	<1
India	94	22	Singapore	6	1
Indonesia	20	5	Sri Lanka	21	5
Iraq	1	<1	Taiwan (China)	20	5
Israel	2	<1	Thailand	11	3
Japan	19	4	UK	13	2
Kenya	1	<1	USA	26	6
Kiribati	1	<1			
			Total	436	

N = 436

Educational attainment

Despite the fact that most respondents were young, they were also highly qualified, with 47% having doctoral degrees and 40% master's degrees (Table 4). In most countries, there were more PhD than MS degrees, offset by Indonesia and the Philippines, where about half were MS degree holders and the remainder equally divided between BS and PhD holders (Table 5). Note that there are discrepancies between the numbers of respondents by nationality (Table 2) and by level of education (Table 5), reflecting movements to overseas institutions, probably for higher degrees.

Table 3. Age of respondents

Age group	*No.*	*%*
61 + above	6	1
56–60	13	3
51–55	29	7
46–50	37	8
41–45	71	16
36–40	89	20
31–35	97	22
26–30	62	14
25 + below	11	3
No response	21	5
$\overline{X}$ = 36.86	Median = 32.02	

N = 436

Table 4. Highest educational attainment of respondents

Level	*No.*
Doctor[1]	205
Master[2]	172
Bachelor[3]	58
By degree titles:	
[3]Bachelor of Science	58
DVM	1
[2]MS	116
MFS	22
MAQ	13
IR	2
MMA	1
PG	3
PG (Dipl)	6
MA	3
PGD (ed)	1
MPH	1
MBA	2
Dipl Fisheries	1
MPH	1
[1]PhD	191
DSc	5
DAg	4
DNS	1
Post-doc	2

N = 435

Table 5. Educational attainment by country of affiliation

Country	*BS*	*MS*	*PhD*
Australia	3	2	12
Bahrain		1	
Bangladesh		1	2
Brunei		2	
Burma (Myanmar)		1	1
Canada			5
China	8	5	
Finland			1
France			1
Germany	1	1	
Hong Kong			2
India	3	41	47
Indonesia	3	10	5
Iraq		1	
Israel			2
Japan	2	3	16
Kiribati		1	
Kuwait	1	1	5
Malaysia	1	10	11
Micronesia			1
Nepal		1	
Netherlands			1
Nigeria		1	
Norway		1	
Pakistan		1	
Panama		1	
Papua New Guinea	1		
Philippines	29	52	28
Saudi Arabia			3
Singapore	1		4
Solomon Islands		1	
Sri Lanka	1	9	10
Taiwan (China)	1	4	17
Thailand	1	5	7
UK			3
USA		4	12
Total	56	160	199

N = 415

Table 6. Institutional affiliation of respondents. A, by type of institution; B, combination of responses.

				No.
A.	*Type*			
	1.	Government		261
	2.	Semigovernment		54
	3.	Private		56
	4.	National		8
	5.	Regional/intern'l		54
	6.	Educational		225
	7.	Research		328
	8.	Voluntary		3
	9.	Other		26
		No response		7
B.	*Combinations:*			
	1	7		51
	6			1
	6	7		221
	5	7		38
	5	7	9	2
	5	9		2
	4	7		6
	9			19
	2	7		4
	3	7	8	1
	6	7	8	1
	5	6		1
	5	6	7	2
	7			1
	7	9		1
	8	9		1

(numbers in left column refer to type numbers in A)

Institutions

The choices offered to respondents on the type of institution to which they belonged called for answers on ownership of the institutions as well as their functions (Table 6). On ownership, 70% of those answering were in government institutions, the remainder equally divided (14.5% each) between semigovernment and private, and a few in voluntary organizations. On function, most respondents (75%) were researchers, while 52% were educators/academics. One-third of all respondents were educators *and* researchers, probably representing university employees. Thus, perhaps 79 persons (18%) of the total were from other educational establishments and 182 persons (42%) were from other research organizations.

Specializations

Respondents were requested to indicate their educational specialization and/or their research specialization. The variety of answers was very broad and was condensed into 24 categories (Table 7). The largest educational grouping was zoology (18%), followed by aquaculture (15%), biology (10%), fisheries science (9%) and marine biology/hydrobiology (8%).

Research specializations followed quite a different order: aquaculture had increased (24%), and was followed by fisheries science and zoology (each 8%). Biology and aquatic biology were reduced to 5% and less than 2%, respectively. However, other research specializations had been taken up after graduation by many correspondents. Fish health, for example increased from 4% of education specialities to 7% of the research specializations; ecology from 3 to 6%; environment from 1 to 3%; genetics from 1 to 2.5%; nutrition from 2.5 to 6%, with physiology, social sciences and postharvest showing increases also. Five respondents were specializing in coastal management while none had their undergraduate or postgraduate education in this field.

One of the most obvious trends noticeable was the tendency to move into aquaculture research, with almost one-quarter of all respondents involved. There seemed to be no similar movement into fisheries science after graduation. Only 4% of respondents had moved into aquatic science from agriculture or general science educational backgrounds.

Research experience

In keeping with the relative youth of the membership, over half the sample had 10 or less years research experience; in fact, 29% had 5 or less years research experience (Table 8). The average for all respondents, however, was 11.4 years. Since this value does not reflect the bulk of the sample, we have chosen to use the modal value, approximately 9 years, for calculating productivity of scientists.

Table 7. Education and research specialization of respondents

	Educational	*Research*
Administration	4	2
Agriculture	12	0
Aquaculture	67	105
Biochemistry/Chemistry	7	5
Biology	45	23
Botany	3	3
Coastal Management	0	5
Ecology	12	27
Environment	6	14
Extension	1	1
Fisheries Science	38	37
Fish Health	18	31
Food Science/Nutrition	11	26
Gear Technology	5	7
Genetics	4	11
Hydrobiology/Marine Biology	34	7
Microbiology/Endocrinology	12	14
Naval Architecture	3	2
Oceanography/Limnology	22	11
Physiology	21	30
Postharvest	12	20
Science (general)	4	0
Social Science	18	24
Zoology	76	36

N = 434

Time spent in research and other activities

(a) Research

Nearly all respondents were engaged in some research. Of the researchers, only 34% managed to spend more than 50% of their time in research. Of that subset, 41% were able to spend 91–100% of their time researching. Of the total sample, however, these full-time researchers comprised only 14% (Table 9).

When the research activities are separated according to educational levels, it can be seen (Table 10a) that the largest or modal group at the bachelor level is spending 91–100% of time on research. For masters and doctoral level respondents the modal group was 41–50%, suggesting a move away from research activities at the higher education levels and/or greater time efficiencies in research.

Table 8. Number of years of respondents in research

Years	*No.*	*%*
46-50	1	<1
41-45	0	0
36-40	4	1
31-35	8	2
26-30	19	5
21-25	25	6
16-20	49	12
11-15	78	19
06-10	109	27
01-05	117	28
unspecified	26	–

N = 436

Table 9. Nature of current activites of respondents as percentage of time allotted to each activity

Activity	*1-10*	*11-20*	*21-30*	*31-40*	*41-50*	*51-60*	*61-70*	*71-80*	*81-90*	*91-100*	*Not an activity*
Research	26	46	62	46	80	22	14	25	18	54	35
Administration	73	42	43	13	40	7	12	8	8	4	173
Teaching	39	29	40	32	50	8	6	6	1	2	199
Consultancy	91	15	9	3	4	0	1	4	2	1	300
Private business	17	3	2	1	3	1	1	3	1	1	416
Extension	82	36	11	3	8	1	3	1	2	3	274

No. of respondents varies for each category

(b) Administration

Despite the overall youth of the Society membership sample, 60% of respondents were involved in administrative work to some extent. Of those so involved 10% spent more than half of their time in administration. The most frequent response was 1–10% administration, by 29% of those so involved, or 17% of all respondents.

Interestingly, there was little difference in time spent on administration between the three levels of education considered (Table 10b). The modal group in all cases was 1–10%. Very few bachelor's level personnel had high administrative loads, while significant numbers of masters and doctoral respondents had administrative loads of up to 50% of their time. Fifty-four per cent of masters, 68% of doctoral and 77% of bachelor degree respondents had some administrative duties.

Table 10a. Use of time according to educational attainment: research

Percentage	*BS*	*MS*	*PhD*	*Total*
0	9	18	8	35
1-10	4	8	14	26
11-20	3	23	20	46
21-30	5	19	38	62
31-40	5	19	22	46
41-50	6	28	46	80
51-60	2	9	11	22
61-70	4	6	4	14
71-80	4	9	12	25
81-90	4	8	6	18
91-100	17	18	19	54

Table 10b. Use of time according to educational attainment: administration

Percentage	*BS*	*MS*	*PhD*	*Total*
0	35	71	67	173
1-10	9	32	32	73
11-20	6	14	22	42
21-30	6	11	26	43
31-40	1	3	9	13
41-50	1	17	22	40
51-60	1	5	1	7
61-70	-	3	9	12
71-80	1	5	2	8
81-90	1	1	6	8
91-100	1	1	2	4

Table 10c. Use of time according to educational attainment: teaching

Percentage	*BS*	*MS*	*PhD*	*Total*
0	49	80	70	199
1-10	3	9	27	39
11-20	1	8	20	29
21-30	4	6	30	40
31-40	-	16	16	32
41-50	3	20	27	50
51-60	-	5	3	8
61-70	1	2	3	6
71-80	-	2	4	6
81-90	1	-	-	1
91-100	1	-	1	2

Table 10d. Use of time according to educational attainment: consultancy

Percentage	*BS*	*MS*	*PhD*	*Total*
0	48	116	136	300
1-10	10	38	43	91
11-20	1	6	8	15
21-30	2	-	7	9
31-40	0	2	1	3
41-50	0	0	4	4
51-60	0	0	0	0
61-70	1	0	0	1
71-80	1	2	1	4
81-90	0	1	1	2
91-100	1	0	0	1

Table 10e. Use of time according to educational attainment: private business

Percentage	*BS*	*MS*	*PhD*	*Total*
0	57	153	206	416
1-10	3	9	5	17
11-20	1	0	2	3
21-30	0	2	0	2
31-40	0	1	0	1
41-50	0	1	2	3
51-60	1	0	0	1
61-70	1	0	0	1
71-80	1	2	0	3
81-90	0	1	0	1
91-100	2	0	0	2

Table 10f. Use of time according to educational attainment: extension work

Percentage	*BS*	*MS*	*PhD*	*Total*
0	39	88	142	274
1-10	9	40	33	82
11-20	4	22	10	36
21-30	2	4	5	11
31-40	2	1	0	3
41-50	2	4	2	8
51-60	1	0	0	1
61-70	1	1	1	3
71-80	1	0	0	1
81-90	2	0	0	2
91-100	0	3	0	3

(c) Teaching

Teaching was an activity of half (52%) the respondents. Typical loads were 50% or less—only 10% of those teaching had a heavier load. At the various educational levels, 23% of bachelor degree respondents, 46% of masters and 65% of PhDs were teaching (Table 10c). Respondent teachers with a masters had heavier loads in general than those with doctorates. The modal group of masters was 41–50% teaching time and that of PhDs, 21–30%.

(d) Consultancy

Thirty per cent of respondents undertook consultancy work. For most (70%) it occupied 10% or less of their time. Only 6% of those consulting did so for more than half of their time. Surprisingly, the percentage of bachelor respondents doing some consulting (25%) was not far below that of masters (30%) and doctoral (33%) respondents (Table 10d).

(e) Private business

A small number of respondents (8%) undertook private business activities other than consulting. The majority of them used only 1–10% of their time in such activities.

(f) Extension

A large number of respondents (35%) undertook extension work, although most of those devoted 10% or less of their time; few spent more than 30% of their time in extension work. Masters-level respondents were more likely (47%) to be involved in extension than bachelor-level (39%) or PhDs (26%) (Table 10f).

Sources of respondents' information

The basic source of knowledge, the scientific journal, is not common on the bookshelves of respondents. The most popular journals are shown in Table 11. Top of the list is the *Bulletin of the Japanese Society for Scientific Fisheries* (now *Nippon Suisan Gakkaishi*). Fourteen of the 18 Japanese respondents received this journal. Most other recipients of this journal were from Taiwan. Next is the *Journal of the Inland Fisheries Society of India* (15) and presumably nearly all subscribers would be in India; similarly the *Fisheries Research Journal of the Philippines* (11) is probably only received by members of the Philippine Fisheries Research Society. In fact, the seven most frequently received journals are publications of professional societies. The total number of different titles received by respondents was 235 and the number of respondents receiving them was 195, or 45% of the total. Finally, more than half of the respondents (55%) do not subscribe to any journal literature at all.

Why do so many respondents not receive any journals? The main reason, given by about half (48%) of the "nonrecipients", was that the library of their

Table 11. Major journals received by respondents

Ranking	*Title*	*No. recipients*
1	*Bulletin of the Japanese Society for Scientific Fisheries (Nippon Suisan Gakkaishi)*	24
2	*Journal of the Inland Fisheries Society of India*	15
3	*Journal of the World Aquaculture Society*	15
4	*Fisheries Research Journal of the Philippines*	11
5	*Transactions of the American Fisheries Society*	11
6	*Journal of Fish Biology*	9
7	*Japan Journal of Ichthyology*	8
8	*Aquaculture*	7
9	*Canadian Journal of Fisheries and Aquatic Science*	5
	Australian Journal of Marine and Freshwater Research	5
	North American Journal of Fisheries Management	5
	Limnology and Oceanography	5
10	*American Journal of Agricultural Sciences*	4
	Coral Reefs	4
	Copeia	4
	Journal of the Marine Biological Association of India	4
	Journal of Food Science	4
	Journal of Environmental Biology	4
	Mysore Journal of Agricultural Science	4

institution was adequate (Table 12). Forty-four per cent indicated that subscriptions were too expensive. The other significant reasons were "able to borrow from others" (18%) and "subscribe to semitechnical magazines instead" (7%). Only one correspondent made photocopies and only one collected reprints.

About 40 respondents included magazines and newsletters in their subscription list. These have been ignored in discussion because the list is very incomplete, and represents only a fraction of available newsletters, etc. (e.g., see Coche 1987). Virtually all Asian members of the Asian Fisheries Society receive *Naga*, the ICLARM Quarterly, free of charge, as well as a variety of project and network newsletters. It is safe to say that nearly all respondents would receive some fisheries-related literature in their mail box.

Information systems and services filled some of the information needs of a few respondents. The numbers using such utilities were very low. Only 19% used any regularly (Table 13), and this is an overestimate since some individuals used more than one service regularly. The main information tool—Aquatic Sciences and Fisheries Abstracts (ASFA)—was regularly used by only 3% of

Table 12. Reasons given by respondents for not subscribing to scientific journals

Rank	*Reasons*	*No.*
1	My library is adequate	115
2	Subscription is expensive	106
3	Able to borrow from other people	43
4	Subscribe to semitechnical magazines instead	17
5	Receive free copies	4
6	Use other libraries	3
7	Photocopy materials I need	1
8	Use reprints	1

respondents. Since ASFA is an expensive item (US$1250/year for the hard copy version in 1990), the lack of its use may be due to unavailability in many libraries, even though so many respondents said their library was adequate. The main information services used regularly were SEAFDEC's Brackishwater Aquaculture Information Service (BRAIS) and ICLARM's Selective Fisheries Information Service (SFIS), although only 2.5% of respondents used them regularly. However, occasional use of these two services was a little better. About one-fifth of respondents used one or other utility occasionally.

Combining regular, occasional and once-only use of the various utilities (Table 13), three of the information services had each been used by 9% of the respondents—SFIS, BRAIS and SAFIS (SEAFDEC's Southeast Asian Fisheries Information Service). Only 3% had ever used ASFA, and the numbers are even more discouraging for the other information utilities mentioned in Table 13.

On a geographical basis, most (78%) of the users of the main information utilities were from the Asia-Pacific area. This is roughly the same proportion as the geographic spread of the respondents themselves, implying broadly similar information use by Asians and non-Asians.

According to Table 14, about 60% of respondents did not use any service, while the number of users (Table 13) implies that 57% did so. As noted earlier, some respondents have probably used more than one service. According to the survey 60% of respondents were nonusers. However, there may have been some confusion as to what was meant by an information service or system and the list in Table 13 as well as the number of users may be underestimated.

The list of nearly 50 services/systems in Table 13 includes some libraries providing regular services and broadly distributed products such as the various Abstract journals and FAO's Contents Tables. They have all been included to show the broad information spectrum relatively easily available to researchers. Note, however, that some services/systems have already ceased to operate—AQUIS, BRAIS, SAFIS, and SFIS.

Table 13. Information systems/services used by respondents

Name of system/service	*Total*	*Frequency*			*Asia-Pacific*	*Others*
		Regularly	*Occasionally*	*Once*		
(a) Major systems/services						
BRAIS (SEAFDEC)	36	11	15	10	34	2
SAFIS (SEAFDEC)	36	4	20	12	30	6
SFIS (ICLARM)	35	11	20	4	29	7
ASFIS (FAO)	27	14	10	3	16	11
DIALOG (USA)	13	6	4	3	6	7
FAO-DS	11	4	6	1	9	2
AQUIS (FAO)	10	4	4	2	8	2
BIOSIS (BIOL. ABSTRACTS)	8	5	1	2	4	4
AGRIS/AIBA	7	2	4	1	7	0
INFOFISH	6	1	3	2	4	2
IDRC-Information Science	4	2	2	0	3	1
INSDOC (?) (India)	4	0	1	3	4	0
Subtotals	197	65	90	43	156	44
(b) Other systems/services used						
CURRENT CONTENTS	3		3			
NAT. CENT. SCI. INFO. (INDIA)	3	1	1	1		
NMFS (Nat. Marine Fish. Serv., USA)	2		1	1		
OASIS (NOAA, USA)	2		2			
USE LIBR SERV (none specified)	2	1		1		
ASEAN Food Handling Bureau	2	2	0	0		
Network of Tropical Fisheries Scientists	2	1	1			
AG. SCI. SERV. CENT. (Taiwan)	1		1	1		
APEX (ASEAN Production Information Exchange)	1			1		
AQUATIC WEED SERVICE	1			1		
BIBLIOFILE	1			1		
BRACKISHWATER AQUACULT. ABSTRACTS (SEAFDEC)	1	1				
CAB-BIOSCIENCES	1	1				
CHEMICAL ABSTRACTS	1	1				
ESA FISH RES. (USA)	1	1				
ENSIS (AIT, Bangkok)	1			1		
FRESHWATER AQUACULTURE CONTENTS (FAO)	1	1				

(Table 13 continued)

Name of system/service	Total	Frequency			Asia-Pacific	Others
		Regularly	Occasionally	Once		
GULF & CARRIBEAN FISH INST.	1		1			
ICMR - UK - IS	1	1				
ICMRD (URI)	1	1				
IIFET (USA)	1			1		
IIS	1			1		
INDEX MEDICUS	1		1			
INFIS (Indonesia)	1		1			
INFO. RET. CENT. (U FA, USA)	1		1			
INFOTERRA (UNEP, Kenya)	1	1				
MARINE FISH. INF. SERV.	1	1				
MEKHONG PROJECT (Thailand)	1			1		
MAR. SCI. CONTENTS TABLES (FAO)	1	1				
NARA LIBRARY (Sri Lanka)	1	1				
NAT. INFO. SCI.	1	1				
NAT. SCI. COUNCIL (Taiwan)	1			1		
NIFI (Thailand)	1		1			
PCARRD SLS (Philippines)	1	1				
PFDA MKT. INFO. (Philippines)	1			1		
REMIN (Malaysia)	1			1		
SFA	1	1				
THAIFIS (SEAFDEC)	1	1				
UBC LIT. SEARCH (CANADA)	1		1			
UNESCO	1	1				
U. HAWAII. LIB SERV.	1		1			
USAID	1		1			
ZOOL. RECORDS	1			1		
Subtotals	53	21	17	15		
Total	250	86	107	58		
Unacceptable responses: 4						

AGRIS = International Information System for the Agricultural Sciences and Technology; AIBA = Agricultural Information Bank of Asia; APEX = ASEAN Production Information Exchange; AQUIS = Aquaculture Information Service of FAO; ASFA = Aquatic Sciences and Fisheries Abstracts from FAO; BRAIS = Brackishwater Aquaculture Information System of SEAFDEC; CAB = Commonwealth Agricultural Bureaux; ENSIS = Environmental Sanitation Information Service; ESA = European Space Agency; ICMR = ?; ICMRD = International Center for Marine Resources and Development, University of Rhode Island; IIFET = International Institute for Fisheries Economics and Trade; IIS = Institute International de Statistique; INFIS = Indonesian Fisheries Information System; NARA = National Aquatic Resources Agency; NIFI = National Inland Fisheries Institute; PCARRD = Philippine Council for Agricultural Research and Resources Development; PFDA = Philippine Fisheries Development Agency; REMIN = Regional Mangrove Information Network for Asia and the Pacific; SAFIS = Southeast Asian Fisheries Information Service; SFA = ? (India); SFIS = Selective Fisheries Information Service of ICLARM; THAIFIS = Thailand Fisheries Information System; UBC = University of British Columbia.

Table 14. Reasons given by respondents for not using aquatic information service/systems

Rank	Reasons	No.
1	Not aware of any in my field	69
2	No service nearby	64
3	No need	54
4	Expensive	44
5	Library adequate	8
6	Other sources available adequate	3
7	No experience	1
8	Have access to inter-library loan	1
9	Request material from author directly	1
	Others (unspecified)	20

The apparent nonusers of information systems/services gave four main reasons for not requesting these utilities (Table 14). Lack of awareness was the chief reason but accounted for only about a quarter of the nonusers. The other main reasons—no service nearby, no need and expensive—accounted for most others.

Although less than half of the respondents received any technical fisheries literature, the most important source of information cited by them was scientific and technical journals (Table 15). Some 30% of all respondents believed this. Second in importance were libraries (18%). All other sources were very minor; less than 2% felt that any other individual source was more important. (Unusable answers to this query were high (30%) mainly because many respondents marked more than one option as being most important.)

The lower level of awareness of the importance of abstract journals (most important to only 7% of respondents), reprints (3%) and information services (1%) was significant.

Output by Respondents

At the time of completion of questionnaires, the 436 respondents had authored 7106 scientific documents, i.e., about 16.3 papers/respondent (Table 16). The modal number of years of research experience is about 9, such that the average productivity seems to be close to two papers per year per respondent. Note that no country data was available for 1248 papers (18%), so that the Table 16 results are low estimates.

Of the published scientific papers, two-thirds (67%) were from the Asia-Pacific region. For all papers, this proportion was 65%. Since Asia-Pacific respondents were 82% of the total, the productivity (papers/scientist/year) in this region was below that of the predominantly Western non-Asian group.

Table 15. Most important sources of aquatic information of respondents

Rank	*Source*	*No.*	*%*
1	Scientific and technical journals	130	30
2	Library	77	18
3	Abstract journals	29	7
4	Personal contacts	20	5
5	Reprints	18	4
6	Scientific meetings	14	3
7	Information services	5	1
	Bibliographies	5	1
8	Networks	4	<1
9	Others		
	Own field work	1	<1
	Books	1	<1
	Primary data	1	<1
Total		305	70

No responses: 39 (9%)

Unacceptable responses: 91 (21%) checked more than one item in list

N = 435

The difference is quite large. Asian scientists averaged 7.1 and 3.6 scientific and other papers, respectively; non-Asians produced on average 15.8 and 10.2 such papers, respectively. In total, these figures represent 1.2 papers per year for Asian and 2.9 per year for non-Asian respondents.

Factors influencing productivity of scientists

An attempt was made to crosscheck the productivity data of Asian scientists and to determine factors among common demographic and economic parameters that might have an influence on their productivity.

For this assessment, an attempt was made to cover all fisheries scientists in the region and their output, rather than the survey sample. Any assessment of scientific productivity among fisheries scientists rests on deciding what constitutes such a title. As noted earlier, "fisheries science" covers a diverse group of disciplines. For Asia the only current guideline is the listing by Chua (1986) based on numbers of scientific and technical personnel in institutions in the various countries. Some Pacific countries were included also. On that basis the following analysis was made.

Table 16a. Number of scientific articles written, by country of author's nationality and per respondent

Region	*No. articles*	*Articles/ scientist*
Asia-Pacific		
Bangladesh	13	2
Brunei Darussalam	1	1
Burma (Myanmar)	34	34
China	170	170
India	788	8.4
Indonesia	26	1.3
Japan	368	19.4
Malaysia	155	6.2
Pakistan	49	10
Papua New Guinea	1	1.
Philippines	422	4
Singapore	49	8.2
Sri Lanka	107	5
Taiwan (China)	267	13.4
Thailand	80	7.3
Subtotal	2,530	
Others		
Australia	224	14
Canada	111	18.3
Chile	1	1
Finland	3	3
France	45	1.5
Germany	3	3
Hungary	1	1
Iraq	41	41
Israel	30	15
Kuwait	4	1
Lebanon	15	15
Netherlands	7	7
Nigeria	3	3
Poland	141	3
Saudi Arabia	12	6
UK	136	11.3
USA	434	16.7
Subtotal	1,211	
No data	824	
Grand total	4,565	

Number of scientists from Table 2

Table 16b. Number of semitechnical/popular articles written, by country of author's nationality and per respondent

Region	*No. articles*	*Articles/ scientist*
Asia-Pacific		
Bangladesh	29	4
Burma (Myanmar)	2	2
China	81	5.4
India	463	5
Indonesia	23	1
Japan	36	2
Malaysia	99.	4
Pakistan	34	7
Papua New Guinea	5	5
Philippines	329	3
Singapore	43	7
Sri Lanka	53	2.5
Taiwan (China)	62	3
Thailand	32	3
Subtotal	1291	
Others		
Australia	141	8.8
Canada	183	30
Chile	10	10
Finland	4	4
France	12	6
Germany	13	6.5
Hungary	10	10
Iraq	4	.4
Israel	25	12.5
Kuwait	9	3
Lebanon	8	8
Netherlands	7	7
Nigeria	5	5
Poland	3	3
Saudi Arabia	7	3.5
UK	16	1.3
USA	336	13
Subtotal	793	
No data	563	
Grand total	2647	

Numbers of scientists from Table 2

Table 16c. Productivity of scientists expressed as average total number of articles (scientific and popular) by nationality

Asia-Pacific	*Total articles/ scientist*	*Others*	*Total articles/ scientist*
Bangladesh	6	Australia	22.8
Brunei Darussalam	1	Canada	48.3
Burma (Myanmar)	16.7	Chile	11
China	13.4	Finland	7
India	2.3	France	7.5
Indonesia	21.4	Germany	9.5
Japan	10.2	Hungary	11
Malaysia	36	Iraq	45
Pakistan	17	Israel	27.5
Papua New Guinea	6	Kuwait	4
Philippines	7	Lebanon	23
Singapore	15.2	Netherlands	14
Sri Lanka	7.5	Nigeria	8
Taiwan (China)	16.4	Poland	6
Thailand	10.3	Saudi Arabia	9.5
		UK	12.6
		USA	29.7

Data from Tables 16a and 16b

The output measure chosen was the number of articles by country in the ASFA CD-ROM database. The other parameters were the density of fisheries scientists (no./100,000 population), annual fish catch and GNP/capita.

A multiple regression analysis of the data using SAS (statistical analysis system) revealed that the number of articles produced annually per country was a function of that country's fish catch and GNP. These two variables accounted for 66% ($r^2 = 0.656$, $n = 23$, $p<0.0001$) of the variation in the data. Of this 66%, fish catch contributed 57%, while GNP accounted for the remaining 9%. The density of scientists was not a significant contributor to the model, although density of scientists was correlated ($r^2 = 0.303$) with GNP. The mathematical expression is:

$$\log_{10} (\text{No. articles/year}) = -3.46 + 0.665 \log_{10} (\text{Annual fish catch}) + 0.413 \log_{10} (\text{GNP})$$

The results are expressed graphically in Figure 1.

The productivity of scientists for each country is also given in Table 17, derived by taking the senior author's affiliation as representing the country of origin. While this results in one entry per article, it includes, as seen in the present survey, non-Asians working in Asian institutions. Bearing in mind the difference in apparent productivities, the results may err on the high side if the ASFA data are representative and fairly complete.

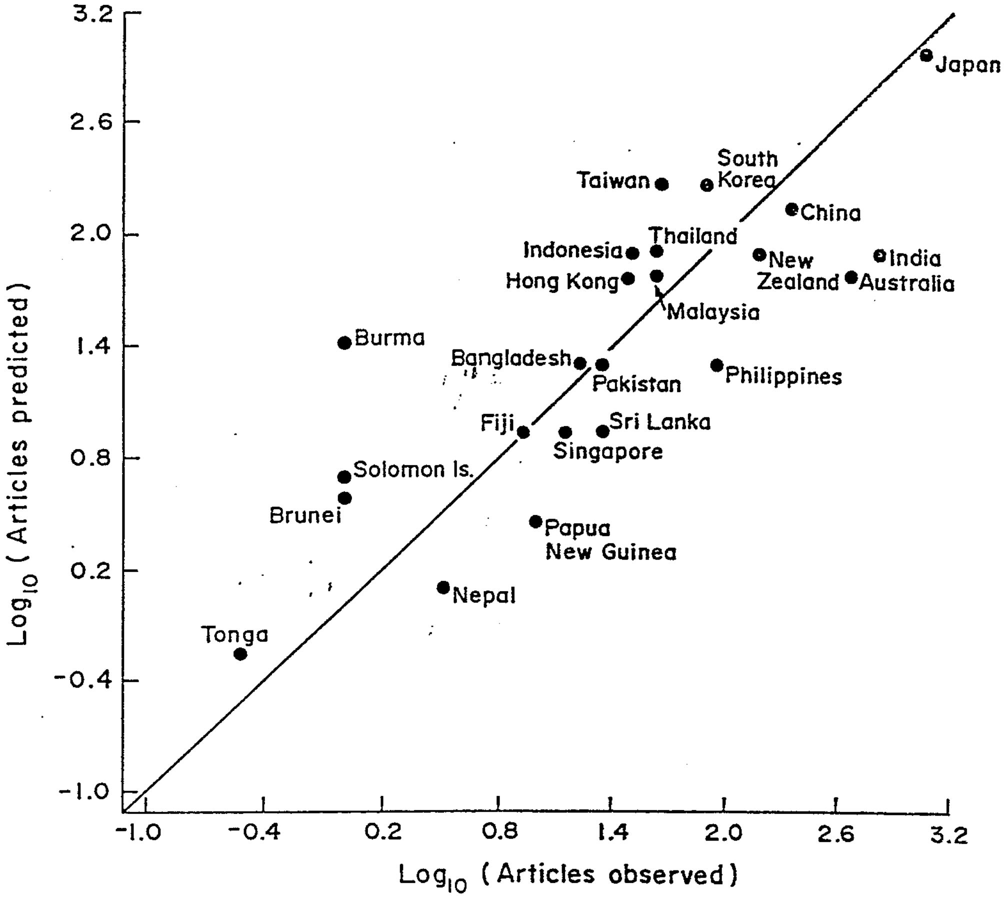

Figure 1. Predicted and observed values of the number of articles produced per year per country based on the multiple regression described in the text. The line represents a perfect observed/predicted correlation (45°).

Productivity as determined in the present survey was on an author-nationality basis. Where there was more than one author and all of them reported the same paper, it would have several entries, again leading to an overestimate (as a rough estimate, there was an average of 1.80 authors per article in the 77 articles comprising volumes 1–3 of *Asian Fisheries Science*, the Society's journal). However, only nationals are represented for each country. All the articles written by each author were included, which is probably not the case in ASFA.

The ASFA data were averaged over eight years (1982–89). The present survey data included all papers to 1987 and were averaged according to the modal number of years (9) of research experience of the respondents.

With all these limitations a comparison of the data in Tables 16c and 17 on papers/year/scientist for countries which appear in both tables (except those with very low numbers of respondents) are shown in Table 18. The survey

Table 17. Demographic, fisheries and literature productivity data in the Asia-Pacific region

Country	*Articles/ year*[a]	*No. scien- tists/100,000*[b]	*Fish catch(t)*[c]	*GNP/ capita($)*[d]	*Papers/year/ scientist*
Australia	484	1.6	200,000	9,500	1.9
Bangladesh	17	0.4	815,000	140	0.04
Brunei Darussalam	1	1.6	2,600	17,000	0.3
Burma (Myanmar)	1	0.06	686,000	170	0.04
China	237	0.15	9.4×10^6	245	0.14
Fiji	8	0.8	35,000	1,400	1.3
Hong Kong	30	0.3	228,000	8,000	1.8
India	700	0.06	2.9×10^6	240	1.4
Indonesia	34	0.18	2.6×10^6	500	0.1
Japan	1,161	0.9	11.8×10^6	15,600	1.0
Korea, South	85	0.47	2.9×10^6	2,100	0.4
Laos	0.1	–	20,000	450	–
Malaysia	44	1.0	608,000	1,800	0.3
Maldives	1.5	–	47,000	250	–
Nepal	3.2	0.3	11,000	140	0.06
Pakistan	22.5	0.2	428,000	300	0.1
PNG	10	0.6	16,000	600	0.5
Philippines	93	0.3	2.0×10^6	600	0.5
Singapore	14	0.6	15,000	6,200	1.0
Solomon Is.	1	4.3	45,000	470	0.08
Sri Lanka	22	0.6	109,000	380	0.2
Thailand	42	0.8	2.2×10^6	750	0.1
Tonga	0.3	1.9	800	1,000	0.1
Vietnam	3	–	870,000	290	–
Taiwan	46	0.7	1,361,000	7,520	0.33
New Zealand	155	4.1	431,000	7,300	1.1

[a] From the Aquatic Sciences and Fisheries Abstracts CD-ROM database; average for 1982-1989. Country was determined by author affiliation.
[b] Population data from FAO yearbooks (for 1987), number of scientists mainly from Chua (1986), using persons with BS or above as scientists and potential authors, except: Burma, using 10% of BS and above as involved in research; China, only assistant engineers and engineers were considered, estimated at 20% of the 8300 technical personnel; India, only MS and above for which data are incomplete; Philippines, MS and higher from Chua et al. (1989); Thailand from Chua (1986) using 50% of B.S. and above involved in research. Taiwan data are 1989, courtesy of Dr I.-C. Liao.
[c] Annual fish production from FAO yearbook (for 1987).
[d] GNP from World Almanac (for 1989).

data in Table 18 compares reasonably with the ASFA data for all countries shown except Bangladesh and China, with Thailand a borderline case.

The present survey results are certainly not unreasonably high and this suggests that there may be severe underreporting in ASFA of the literature in the four countries mentioned earlier. The present survey data also confirm the relationship between productivity of scientists and GNP.

Table 18. Comparison of annual productivity of scientists by country

	No. papers/author/year	
Country	*Chua and Maclean (1988)*	*Present survey**
Australia	1.9	1.4
Bangladesh	0.04	0.4
China	0.14	1.0
India	1.4	0.8
Indonesia	0.1	0.2
Japan	1.0	1.3
Malaysia	0.3	0.6
Philippines	0.5	0.4
Sri Lanka	0.2	0.4
Taiwan (China)	0.3	1.0
Thailand	0.1	0.6

*Apparent productivity from Table 16c divided by the number of estimated number of author/article (1.80)

Nature of the output

A large number of subject descriptors was needed to cover all the documents authored by respondents. There were 50 descriptors with more than 30 entries (Table 19) and these were then lumped into a few broad categories (Table 20).

General biological topics comprised 48% of the total. Two subjects, nutrition and pathology, which belong to this category, were separated in view of their prominence (18%). The overall biological subject matter was thus about two-thirds of the total. Only 11% of descriptors related to fisheries (biology, management or socioeconomics) and 16% to aquaculture.

This generalization is a crude one. However, the diversity of subject matter of research by respondents can be seen to be very high, with perhaps less than one-third being applied according to the definitions of fisheries science cited at the beginning of this report. It can be concluded that most effort in the region is directed towards background and basic research on fish.

Supporting evidence for the low proportion of applied fisheries literature output is the proportion of scientists in the various Southeast Asian fisheries institutions who considered themselves as working in fisheries management, stock assessment, population dynamics or socioeconomics—12% (Chua and Maclean 1988), close to the 11% literature output in this field determined for Society respondents in the present study.

Table 19. Major subject descriptors of respondents' publications

Descriptor	*No. of documents*	*Descriptor*	*No. of documents*
Abiotic factors	59	Fish diseases	94
Activity pattern	36	Fishery biology	92
Agropisciculture	32	Fishery economics	45
Analytical techniques	56	Fishery management	45
Animal nutrition	49	Food organisms	36
Aquaculture	58	Food technology	34
Aquaculture techniques	129	Freezing storage	48
Aquatic communities	106	Freshwater aquaculture	43
Aquatic organisms	98	Induced breeding	49
Bacteriology	33	Interspecific relationships	47
Biochemistry	67	Man-induced effects	32
Biogeography	31	New taxa	41
Biological data	49	Operation research	36
Biological development	92	Parasites	97
Biological phenomena	36	Parasitism	38
Biological properties	113	Pollution effects	36
Biotic factors	38	Pond culture	35
Botany	40	Prawn culture	56
Check lists	87	Reproductive behavior	49
Crustacean larvae	35	Research programs	32
Developmental stages	36	Resource management	37
Distribution records	48	Sexual cells	47
Feeding behavior	90	Sociological aspects	55
Feeding experiments	74	Taxonomy	167
Fish culture	153	Water pollution	33

Table 20. Summary of major subject descriptors of respondents' publications

General descriptors	*No.*	*Proportion (%)*
Aquaculture related	463	16
Fisheries biology, socioeconomics, management	310	11
Food technology	82	3
General biology	1,378	48
Nutrition, feeding	249	9
Pathology	262	9
Pollution	101	4
Total	2,845	100

The relative productivity of Asian and non-Asian members is further compared in Tables 21 and 22 by nationality and affiliation. By nationality, Asian scientists contributed about half of all single author articles. They were senior authors on half of all articles where there was more than one author. However, they were junior authors on only 14% of multiauthored articles. Asian scientists had an editorial role in only 16% of edited documents.

The influence of non-Asians in the region becomes evident in Table 22. It is clear that non-Asian respondents working in institutions within the region have a marked effect on productivity. Whereas Asian scientists contribute 40% overall to author/editorship of Society members' documents (Table 21), Asian institutions account for 70% of the documents (Table 22).

Table 21. Number of scientific papers written according to type of authorship by nationality

	Asia-Pacific	*Others*	*Subtotal*	*% Asia-Pacific*
Senior author	1,114	1,000	2,114	53
Single author	1,631	1,679	3,310	49
Coauthor	275	1,670	1,945	16
Single editor	5	22	27	19
Senior editor	5	20	25	20
Coeditor	0	12	12	0
Single reviewer	0	5	5	0
Senior reviewer	0	2	2	0
Subtotals	3,030	4,410	7,440	41
No data	68	34	102	0
Total			7,542	

Table 22. Number of scientific papers written according to authorship by affiliation

	Asia-Pacific	*Others*	*Subtotal*	*% Asia-Pacific*
Senior author	1,499	615	2,114	71
Single author	2,283	1,027	3,310	69
Coauthor	1,355	590	1,945	70
Single editor	23	4	27	85
Senior editor	20	5	25	80
Coeditor	9	3	12	75
Single reviewer	0	5	5	0
Senior reviewer	0	2	2	0
Subtotals	5,189	2,251	7,440	70
No data	89	13	102	0
Total			7,542	

From Tables 21 and 22, the influence of non-Asians in Asian-based institutions is strongest in the coauthor field, suggesting that the level of collaborative research within the region is high (non-Asian influence in the editorial field is also high but the absolute numbers are low).

Discussion

The present survey has few points of comparison. Its results are based on a large sample, including nearly 10% of all Asian fisheries scientists, estimated to be about 3600 in 1983.

One reference point is the publication rate of articles as captured by ASFA. In Table 17, the ASFA "harvest" was found to be about 3700 articles/year for Asia (averaging 1982–89 data). The publication estimate for Asian (Pacific) scientists in the survey sample is about 3500, including as does ASFA, semitechnical publications. The results are close.

From the survey data, 60% of all Asian publications can be classed as scientific (as opposed to semitechnical/popular articles), including journal articles, proceedings papers and reports. This is lower than the proportion found in the earlier survey of ASFA records by Chua and Maclean (1988) which found 75% of Indo-Pacific related documents to be scientific articles, proceedings papers or reports.

Elsewhere in the text, comparisons on productivity have been made. These should not be taken too seriously in view of the dissimilarity of data, but it is hoped that they give food for thought as well as provide a benchmark on the activities of a large sample of scientists working in Asia.

A gratifying feature of the results is the finding that Asian scientists are productive and that the extensive criticisms of developing-country literature cited in the Background section of this report are unfounded. That the majority of the literature is not cited in the ISI database reflects the fact that most of the work deals with national or regional or even international issues (e.g., tropical fisheries science) not relevant to most scientists in Western countries. Neither are the differences in productivity (papers/author/year; Table 18) great among the scientists of many Asian countries.

Various authors (summarized in Davis and Eisemon 1989) have noted that even if productive, Asian scientists produce articles that are of lower quality in that they cite older literature than do their Western counterparts. A study of Philippine biological scientists (Maclean and Vega 1990) showed that citations in articles in the major Philippine fisheries journal (*Fisheries Research Journal of the Philippines*) had a mean age of 9.2 years, little different from citations in a major Western journal such as *Aquaculture* (8.1 years).

Thus, the successful developing-country scientists—those publishing in the primary literature, whether or not covered by ISI—probably behave in a similar manner to their Western counterparts, even if not quite as productively.

The disturbing feature of the present survey results is the lack of use of available information sources by the majority of respondents. ICLARM, through its Selective Fisheries Information Service, is one such source. Through that Service, the Center has learnt that few scientists have the capacity (or willingness) to pay for information. This poses a dilemma for information producers/providers, which is well known also to donor agencies. Funding information appears to be feeding a bottomless pit. Not providing information, however, can eventually cause meaningful research to come to a complete standstill. As Jay Ogilvy, quoted in Brand (1988), put it: "A Nobel Prize is waiting for the person who figures out the economics of information".

Information sources, such as ICLARM, have a responsibility to seek ways to provide maximum information at minimum costs to both clients and donors. From the present survey, the main guideline is very clear: that the available information has to be passed around more efficiently and more effectively.

References

Arunachalam, S. 1979. Scientific journals in India. Their relevance to international science. *Science Today* March 1979: 45–50.

Arunachalam, S. and K. C. Garg. 1986. Science on the periphery—a scientometric analysis of science in the ASEAN countries. *Journal of Information Science* 12: 105–117.

Arunachalam, S. and S. Markanday. 1981. Science in the middle-level countries: a bibliometric analysis of scientific journals of Australia, Canada, India and Israel. *Journal of Information Science* 3: 13–26.

Asian Fisheries Society. 1988. Workshop statement on fisheries education and training in Asia. In *Fisheries education and training in Asia: Workshop proceedings*. Asian Fisheries Society Special Publication 2, 1–6. Manila, Philippines: Asian Fisheries Society.

Baldauf, R. B. Jr and B. M. Jernudd. 1983. Language use patterns in the fisheries periodical literature. *Scientometrics* 5: 245–55.

Brand, S. 1988. *The media lab*. New York: Penguin Books.

Calleja, G. B. 1980. Science in the boondocks. *Filipinas: a Journal of Philippine Studies* 1: 21–43.

Chua, T. E. 1986. Aquaculture training in developing Asia. *Naga, the ICLARM Quarterly* 9(4): 7–10.

Chua, T. E., M. A. A. Agulto, F. Y. Guarin and S. C. Guerrero. 1989. *Directory of institutions and scientists in the ASEAN region involved in research and/or management related to coastal areas*. Manila, Philippines: ICLARM.

Chua, T. E. and J. L. Maclean. 1988. Has scientific research in Asia contributed to Asian fisheries development? In *The First Indian Fisheries Forum, Proceedings*, ed. M. Mohan Joseph, 5–8. Mangalore, India: Asian Fisheries Society, Indian Branch.

Coche, A. G. 1987. *Selected aquaculture publications: serials, newsletters, meeting proceedings, and bibliographies/directories/glossaries*. FAO Fisheries Circular 808, 108 pp. Rome: FAO.

Davis, C. H. and T. O. Eisemon. 1989. Mainstream and non-mainstream scientific literature in four peripheral Asian scientific communities. *Scientometrics* 15(3-4): 215–39.

Dizon, L. B. 1991. *An analysis of citations to the* Fisheries Research Journal of the Philippines *and* Kalikasan, the Philippine Journal of Biology, MLS special publication, 98 pp. Diliman, Quezon City: Institute of Library Science, University of the Philippines.

Everhart, W. H., A. W. Eipper and W. D. Youngs. 1975. *Principles of fishery science.* New York: Cornell University Press.

Freeman, R. R. 1988. Bibliographic coverage of the growing fisheries literature in ASFA. *Naga, the ICLARM Quarterly* 11(1): 5.

Fuseler-McDowell, E. 1989. Documenting the literature of marine biology. In *Marine science information throughout the world: sharing the resources,* ed. C. P. Winn, R. W. Burkhart and J. C. Burkhart, 45–60. St. Petersburg, Florida: International Association of Marine Science Libraries and Information Centers.

Garfield, E. 1983. Mapping science in the third world. *Science and Public Policy* 10(3): 112–27.

Knorr, K. D., R. Mittermeir, G. Aichholzer and G. Waller. 1979. Individual publication productivity as a social position effect in academic and industrial research units. In *Scientific productivity. The effectiveness of research groups in six countries,* ed. F. M. Andrews, 55–94. Cambridge: Cambridge University Press, and Paris: UNESCO.

Maclean, J. L. 1982. Fisheries literature services: an overview. *ICLARM Newsletter* 5(2): 3–5.

Maclean, J. L. 1988a. The growth of fisheries literature. *Naga, the ICLARM Quarterly* 11(1): 3–4.

Maclean, J. L. 1988b. An overview of fisheries education and training in Asia. In *Fisheries education and training in Asia: Workshop proceedings.* Asian Fisheries Society Special Publication 2, 12–16. Manila, Philippines: Asian Fisheries Society.

Maclean, J. L. and M. J. M. Vega. 1990. Citation behavior of Philippine biological scientists. Paper presented at the International Conference on Science Indicators for Developing Countries, 14–19 October 1990, Unesco, Paris, France.

Maclean, J. L., R. M. Temprosa, N. I. Jhocson and A. F. Diaz. 1990. *Bibliographic impact of ICLARM.* ICLARM Technical Report 26, 19 pp. Manila, Philippines: ICLARM.

Morgan, G. R. and K. D. Hopkins. 1986. Productivity of fisheries laboratories in lesser developed countries. *ICLARM Newsletter* 9(2): 3–4.

Nababan, P. W. J. 1985. Bilingualism in Indonesia: ethnic language maintenance and the spread of the national language. *Southeast Asian Journal of Social Sciences* 13(1): 1–18.

Nature. 1981. Productivity by numbers. *Nature* 292: 665.

Needham, R. 1982. ASFIS: vehicle for international exchange of scientific information. *ICLARM Newsletter* 5(2): 5–8.

Pauly, D. 1984. Who cites your publications when you work in the tropics? *ICLARM Newsletter* 7(2): 6–7.

Royce, W. F. 1972. *Introduction to the fishery sciences.* New York: Academic Press.

Sarria, J. P., ed. 1982. *Fisheries bibliography.* Vol. 1. (1976-1982). Los Baños, Philippines: Southeast Asian Regional Center for Graduate Study and Research in Agriculture.

Schubert, A., W. Glanzel and T. Braun. 1987. World flash on basic research. Subject field characteristic citation scores and scales for assessing research performance. *Scientometrics* 12: 267–91.

Schubert, A., W. Glanzel and T. Braun. 1989. Scientometric datafiles. A comprehensive set of indicators on 1649 journals and 96 countries in all major science fields and subfields 1981-1985. *Scientometrics* 16: 34–78.

SEAFDEC. 1985. *Report of the SAFIS Seminar on Fisheries Extension Literature,* Bangkok, Thailand, 5–8 February 1985. Bangkok, Thailand: Southeast Asian Fisheries Development Center.

Sibayan, B. P. 1985. Reflections, assertions and speculations on the growth of Pilipino. *Southeast Asian Journal of Social Sciences* 13(1): 40–51.

Yuthavong, Y. 1983. The input and output of science and technology in Thailand. *Journal of the Science Society of Thailand* 9: 1–4.