

SPECIES DIVERSIFICATION IN AQUACULTURE

A GLOBAL ASSESSMENT

Dr. Junning Cai (FAO)

International Institute of Fisheries Economics
and Trade (IIFET) Conference 2016
Monday 11 - Friday 15 July 2016
Aberdeen, Scotland



Co-authors

CAI, Junning: Food and Agriculture Organization (FAO) of the United Nations, Rome, Italy.

YAN, Xue: Chinese Academy of Fishery Sciences, Beijing, China

ZHOU, Xiaowei: Food and Agriculture Organization (FAO) of the United Nations, Rome, Italy.

Aquaculture species diversification: a popular notion attractive to policymakers and other experts

This paper would:

- Examine/clarify the concept and measurement of species diversification in aquaculture
 - For systematic assessment and monitoring species diversification in aquaculture
- Examine the status and trend of species diversity in aquaculture at the global, regional and national levels and highlight some salient patterns or stylized facts of species diversification in aquaculture
 - Providing knowledge and information for evidence-based policymaking and business planning
- Explore how to use species diversity measures to facilitate evidence-based decision makings
- Serve as a background paper for the Aquaculture Production Module under the World Aquaculture Performance Indicators (WAPI).

Part I: Data and method

Data source: FAO data on aquaculture production (FishSTAT)

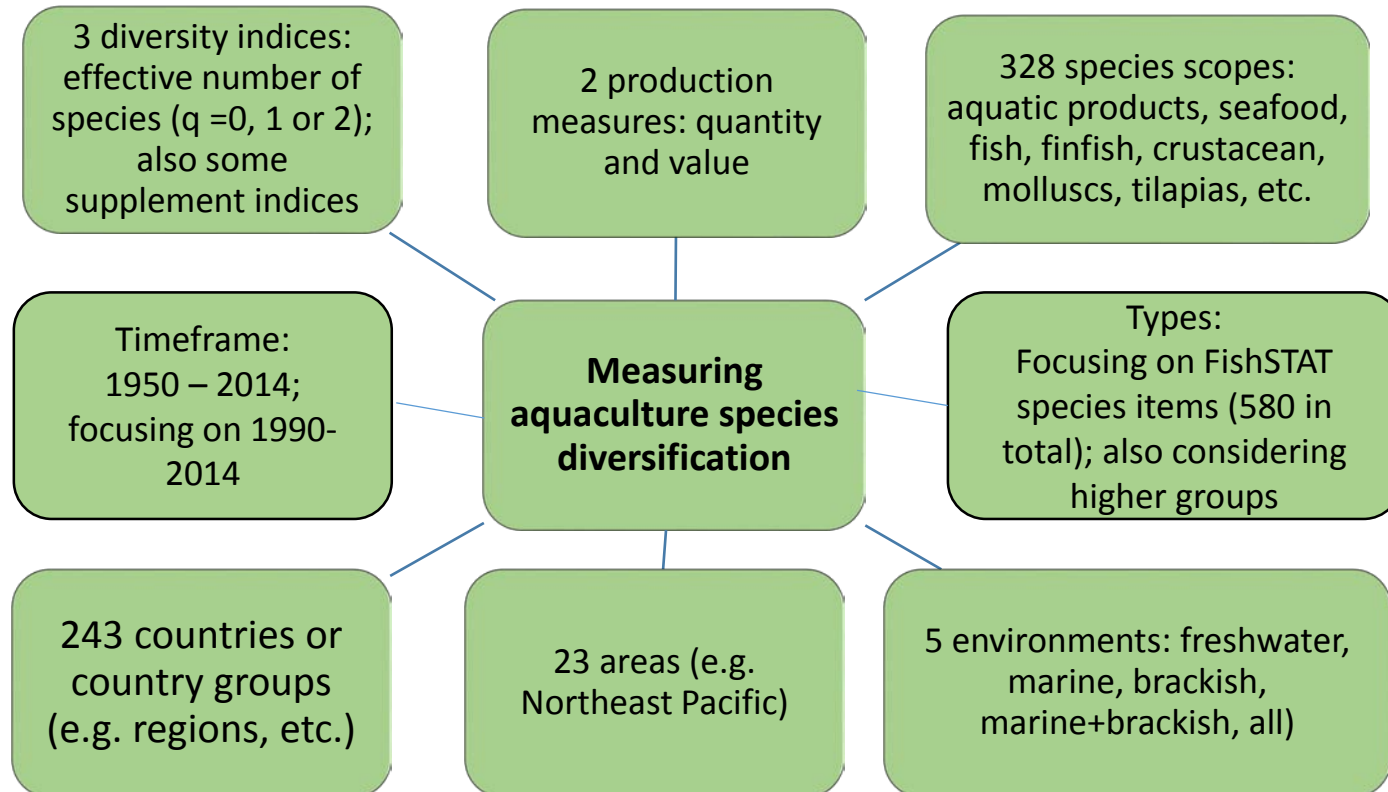
The most comprehensive dataset on global aquaculture production

- Covering 206 countries or territories
- 580 species items
- Quantity data from 1950 – 2014; value data from 1984 – 2014.
- Different farming environments: freshwater, brackishwater, marine

Imperfect data

- Data submitted by countries may not be accurate.
- Some FishSTAT species items are actually species groups.
- Some species-level data are estimated from more aggregated level.
- Value data are less reliable than quantity data.

Multiple dimensions of species diversification measurement



Diversity indices

Effective number of species (true diversity)

Basic indices

$$D_q = \left(\sum_{i=1}^n s_i^q \right)^{1/(1-q)} \quad \text{n is the number of species}$$

$q = 0$: $D_0 = n$ measuring the richness.

$q = 1$: $D_1 = \exp(-\sum_{i=1}^n s_i \ln(s_i))$ equivalent to Shannon-Wiener-Weaver (entropy) index.

$q = 2$: $D_2 = (\sum_{i=1}^n s_i^2)^{-1}$ equivalent to the inverse Simpson-Hirschman-Herfindahl index.

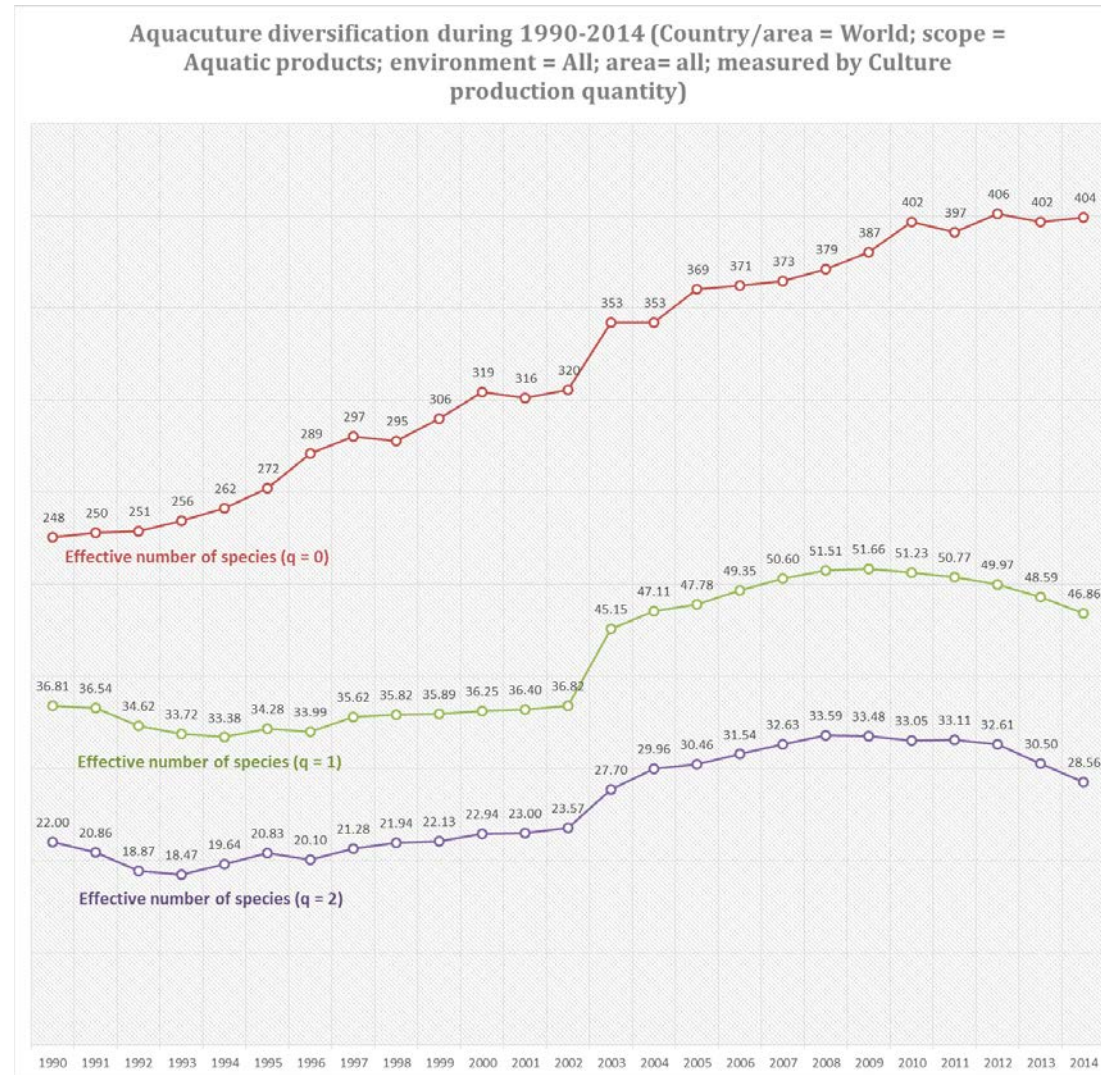
Supplement/derivative indices

Gamma diversity (γ) = alpha diversity (α) \times beta diversity (β)

D_1/D_0 or D_2/D_0 as a measure of evenness?

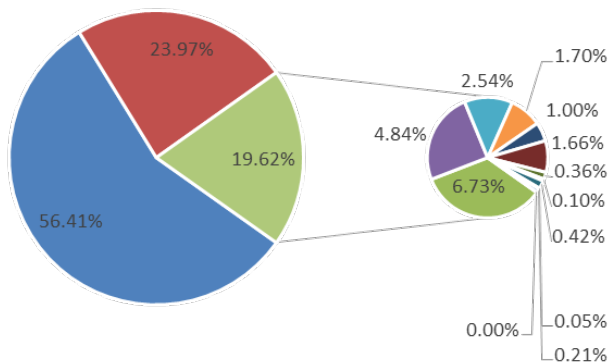
Some notes on diversity indices

- $D_{q=0} \geq D_{q=1} \geq D_{q=2}$
- It is not unusual that $D_{q=0}$ and $D_{q=1}$ (or $D_{q=2}$) have opposite indication of species diversification.
- $D_{q=1}$ and $D_{q=2}$ usually have consistent indication of species diversification.
- $D_{q=1}$ and $D_{q=2}$ may have opposite indication of species diversification.

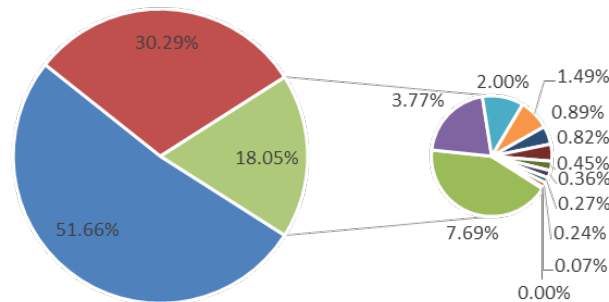


A case of $D_{q=1}$ and $D_{q=2}$ giving opposite indication of species diversification

2011



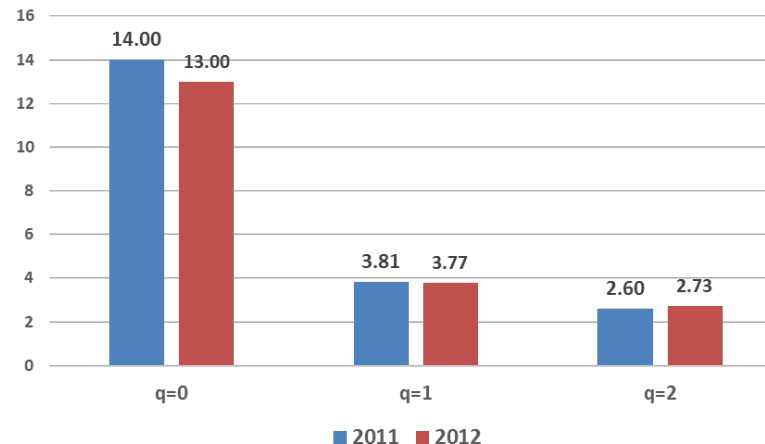
2012



- Bastard halibut (*Paralichthys olivaceus*)
- Korean rockfish (*Sebastes schlegeli*)
- Flathead grey mullet (*Mugil cephalus*)
- Silver seabream (*Pagrus auratus*)
- Japanese seabass (*Lateolabrax japonicus*)
- Blackhead seabream (*Acanthopagrus schlegeli*)
- Porgies, seabreams nei (*Sparidae*)
- Marine fishes nei (*Osteichthyes*)
- Filefishes, leatherjackets nei (*Monacanthidae*)
- Mackerels nei (*Scombridae*)
- Scorpionfishes nei (*Scorpaenidae*)
- Japanese amberjack (*Seriola quinqueradiata*)
- Groupers nei (*Epinephelus* spp)
- Japanese jack mackerel (*Trachurus japonicus*)

Farmed marine fish species in Korea: Which year is more diversified, 2011 or 2012?

Diversity indices



Quantity vs. value measures

Generally speaking, species diversity measured in terms of value greater than that measured in terms of quantity

q=1; Scope =Aquactic products; Environment=All; Area=All; year=1990-2014					Number of cases where D_value / D_quantity					D_value/D_quantity				
region	All cases	>1	1	<1	Mean	95% confidence interval		Min	Max					
Africa	1,079	428	306	345	0.99	0.98	1.01	0.31	2.61					
Asia	1,104	591	145	368	1.11	1.09	1.13	0.28	4.66					
Europe	963	506	22	435	1.09	1.07	1.12	0.64	4.46					
LAC	849	232	132	485	0.95	0.94	0.96	0.37	2.06					
Northern America	54	25	3	26	1.05	0.96	1.13	0.63	1.62					
Oceania	340	174	93	73	1.12	1.09	1.16	0.63	3.84					
World	4,389	1,956	701	1,732	1.05	1.04	1.06	0.28	4.66					

Cases of large deviation between D_quantity and D_value

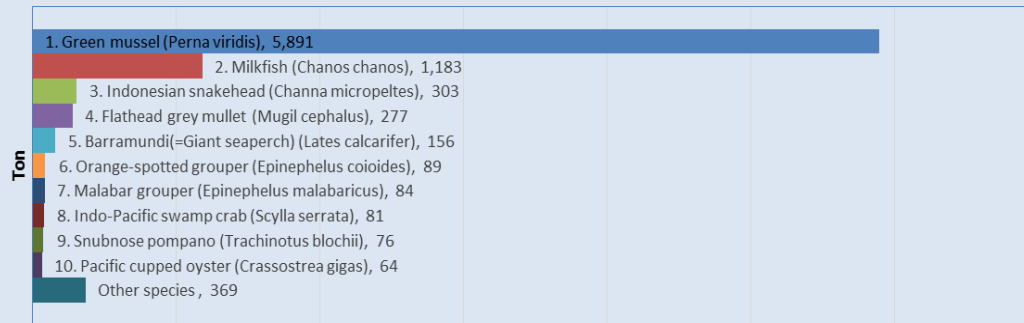
Top-10 countries with the greatest D_value/D_quan						Top-10 countries with the smallest D_value/D_quan					
region	year	countries	D_value	D_quantity	D_value/D_quan	region	year	countries	D_value	D_quantity	D_value/D_quan
Asia	2006	Singapore	17.01	3.65	4.66	Asia	2000	Thailand	2.08	7.48	0.28
Europe	1998	Spain	9.45	2.12	4.46	Africa	2010	South Africa	1.84	5.86	0.31
Oceania	1992	Fiji, Republic of	4.70	1.22	3.84	LAC	1997	Mexico	1.66	4.53	0.37
Asia	1993	Malaysia	11.57	3.52	3.29	LAC	2004	Uruguay	1.24	3.31	0.37
Asia	2008	Timor-Leste	3.77	1.28	2.94	Asia	2009	Sri Lanka	2.08	4.66	0.45
Africa	2005	Tanzania, United Rep. of	2.69	1.03	2.61	Africa	1990	Mauritius	1.74	3.64	0.48
Asia	2013	Indonesia	12.35	4.76	2.59	Africa	2005	Mozambique	2.21	4.36	0.51
Asia	2013	Korea, Republic of	14.59	6.72	2.17	Africa	1994	Tunisia	2.49	4.82	0.52
LAC	2009	Jamaica	2.37	1.15	2.06	Asia	2007	China, Hong Kong SAR	4.31	7.93	0.54
Europe	1998	Netherlands	2.71	1.34	2.03	Africa	2006	Madagascar	1.51	2.76	0.55

Year: 1990-2014; Area = All; Environment = All; Scope = Aquatic products; Diversity measure (q =1)

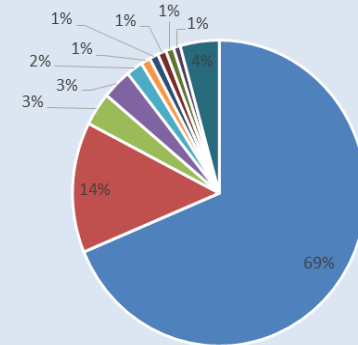
Singapore in 2006: a case of D-value >> D_quantity

Diversity measured by quantity = 3.65

Singapore in 2006: Top-10 species groups under WAPI FishSTAT species grouping

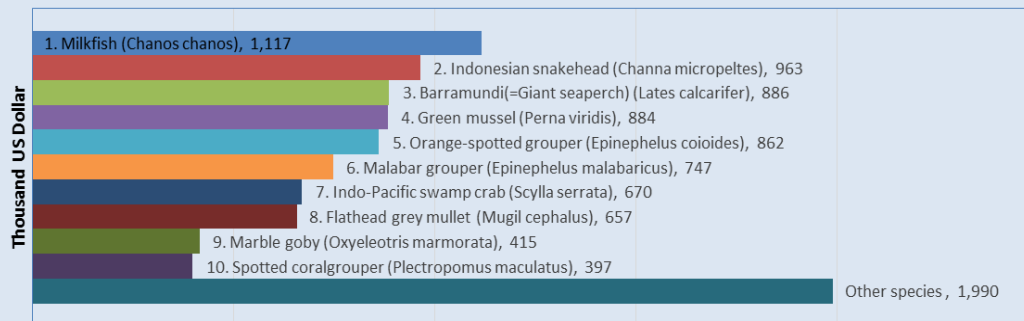


Share in total aquatic products (%)

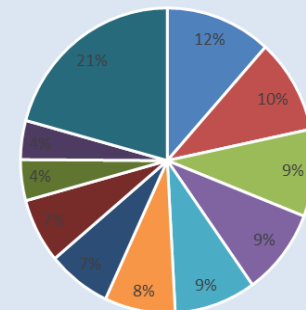


Diversity measured by value = 17.01

Singapore in 2006: Top-10 species groups under WAPI FishSTAT species grouping



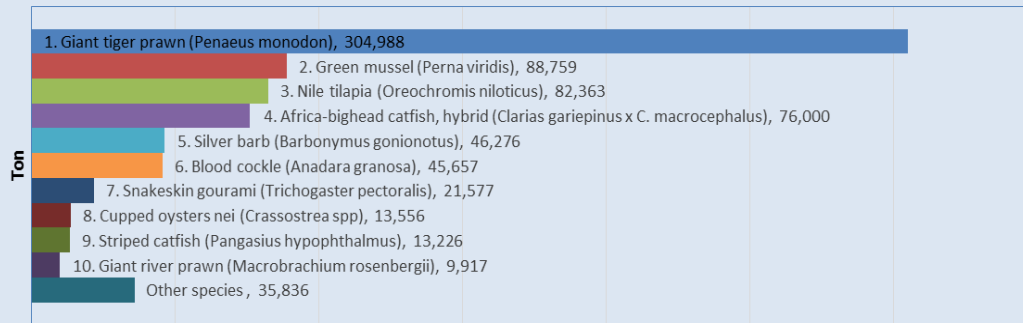
Share in total aquatic products (%)



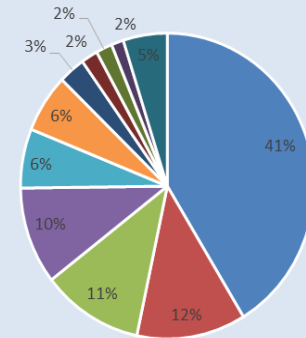
Thailand in 2000: a case of $D_{\text{value}} \ll D_{\text{quantity}}$

Diversity measured by quantity = 7.48

Thailand in 2000: Top-10 species groups under WAPI FishSTAT species grouping

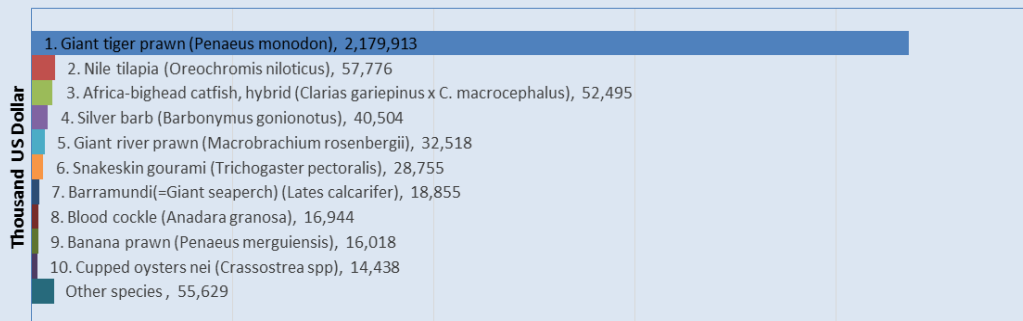


Share in total aquatic products (%)

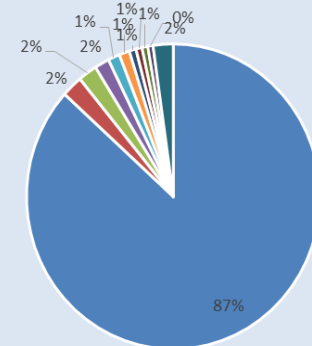


Diversity measured by value = 2.08

Thailand in 2000: Top-10 species groups under WAPI FishSTAT species grouping

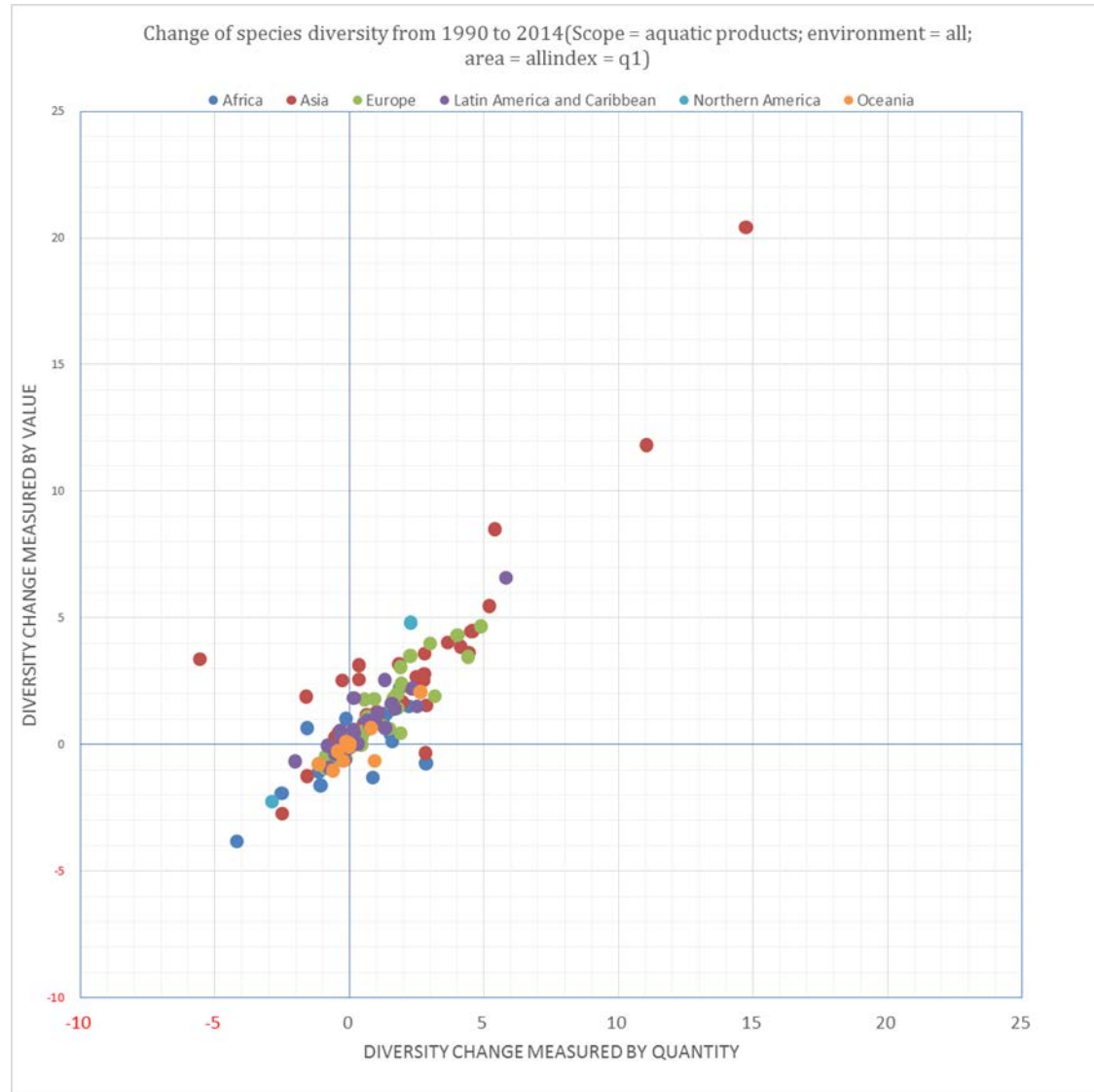


Share in total aquatic products (%)

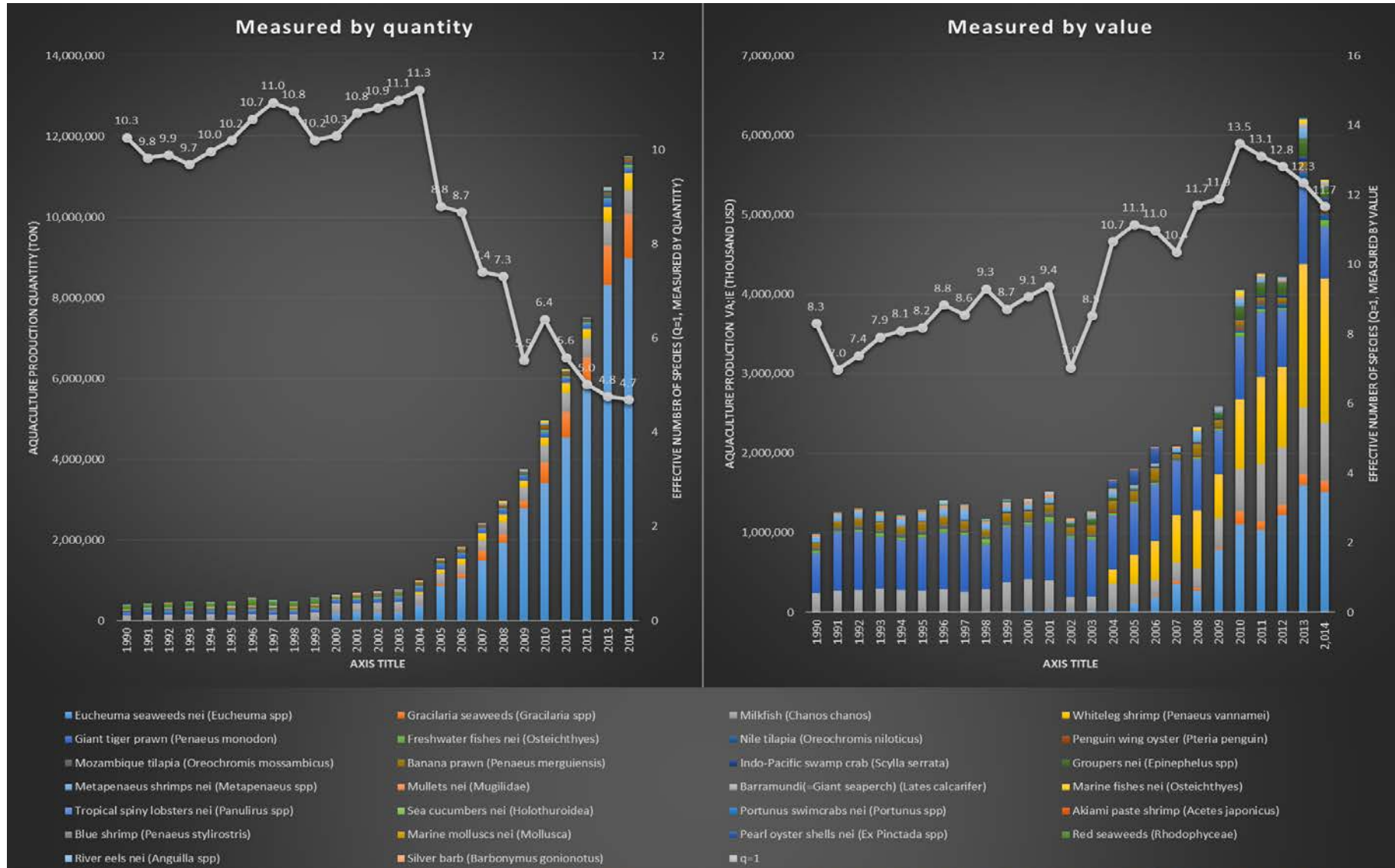


Quantity and value-based diversity measures tend to give similar indication of changes in diversity

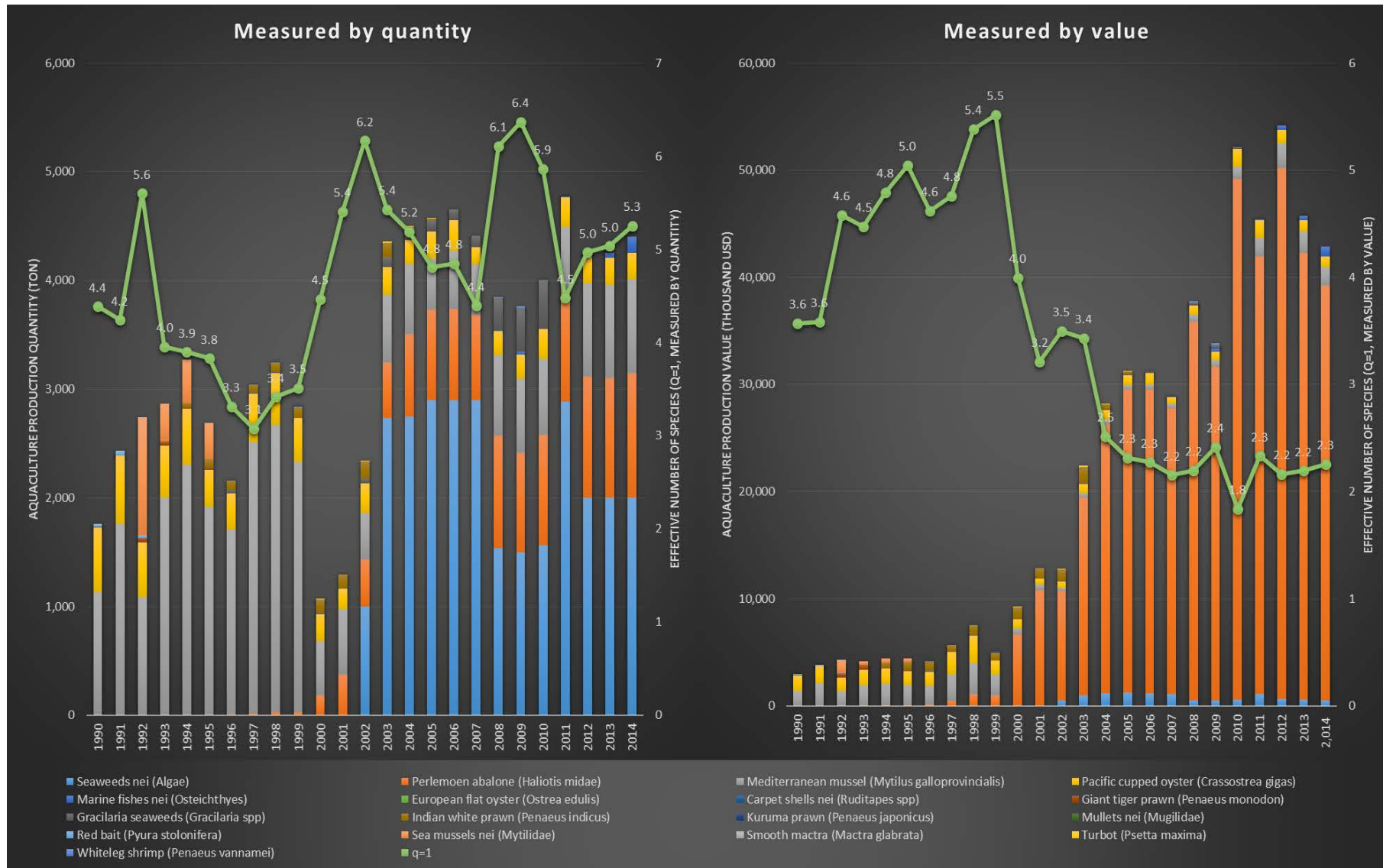
- Among 7131 cases of changes in species diversity from 1990 to 2014 for various countries, scopes, and environments, the two measures indicate opposite changes in diversity in 348 cases.
- For Scope = Aquatic products and Environment = All, the two measures indicate opposite changes in 19 out of totally 152 cases (see chart to the right).



Indonesia: a case of quantity and value-based diversity indices give opposite indication of species diversification



South Africa: a case of quantity and value-based diversity indices give opposite indication of species diversification

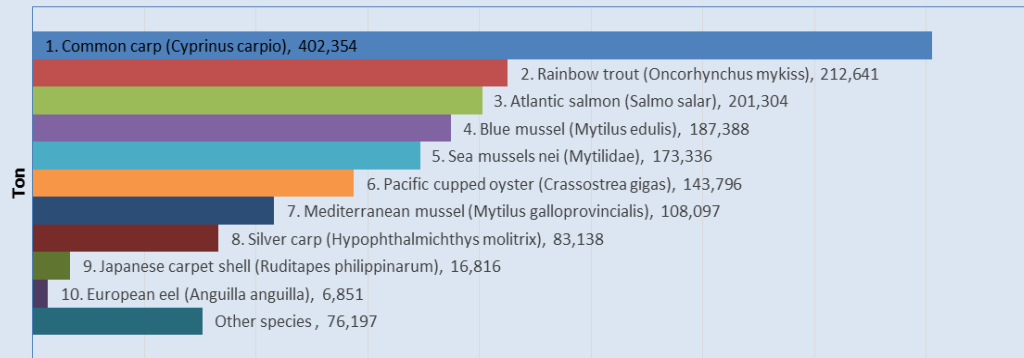


Geo-scale: country and region

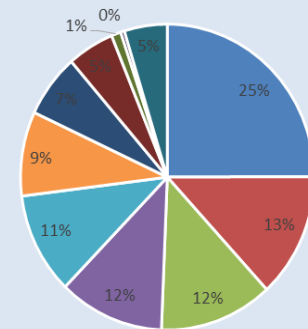
Top-10 species in Europe: 1990 vs. 2014

Diversity in 1990 = 9.8

Europe in 1990: Top-10 species groups under WAPI FishSTAT species grouping



Share in total aquatic products (%)

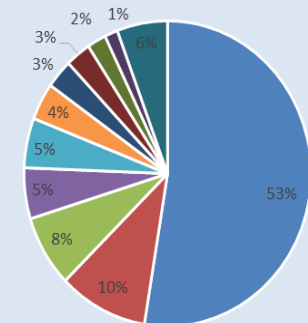


Diversity in 2014 = 6.7

Europe in 2014: Top-10 species groups under WAPI FishSTAT species grouping

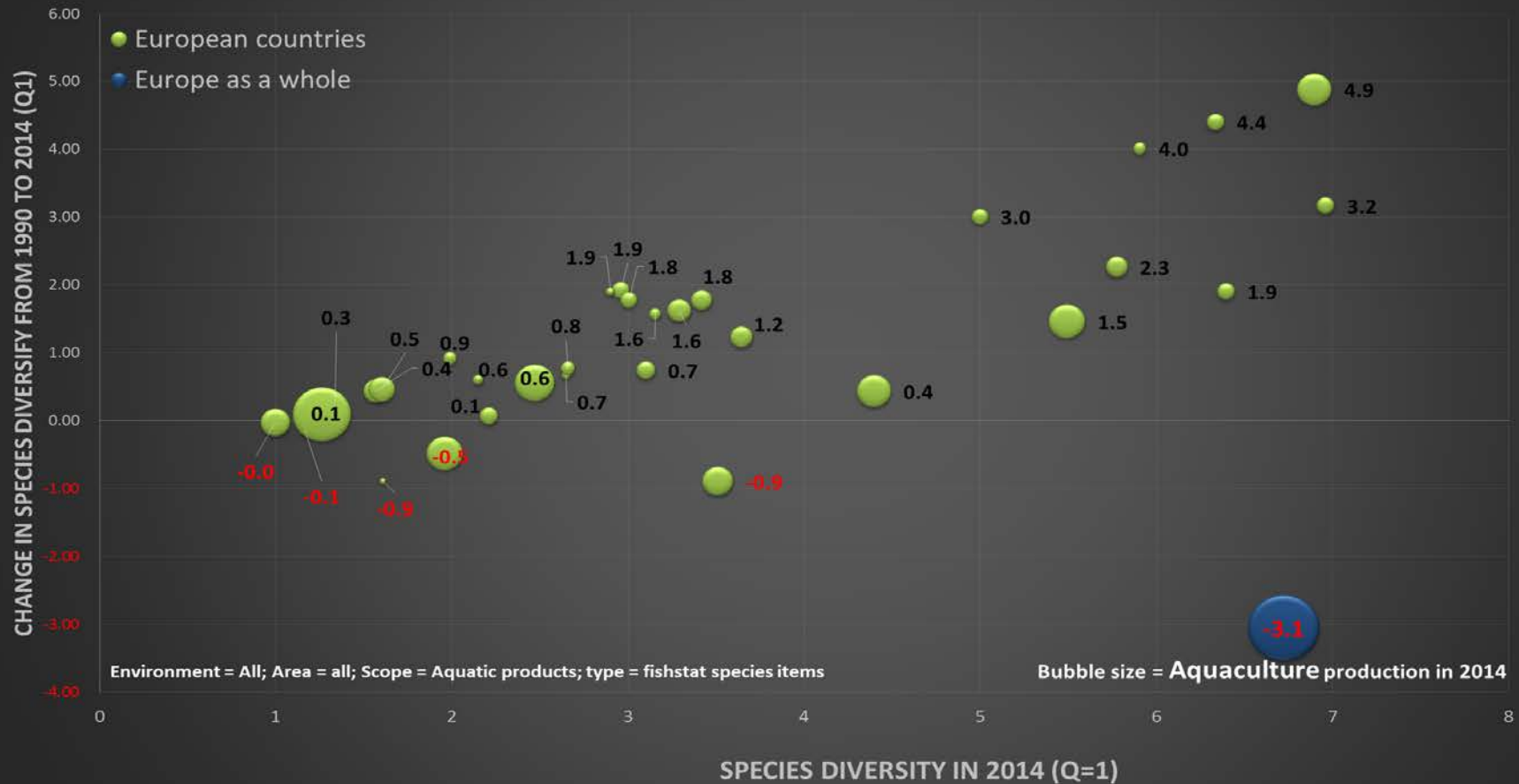


Share in total aquatic products (%)



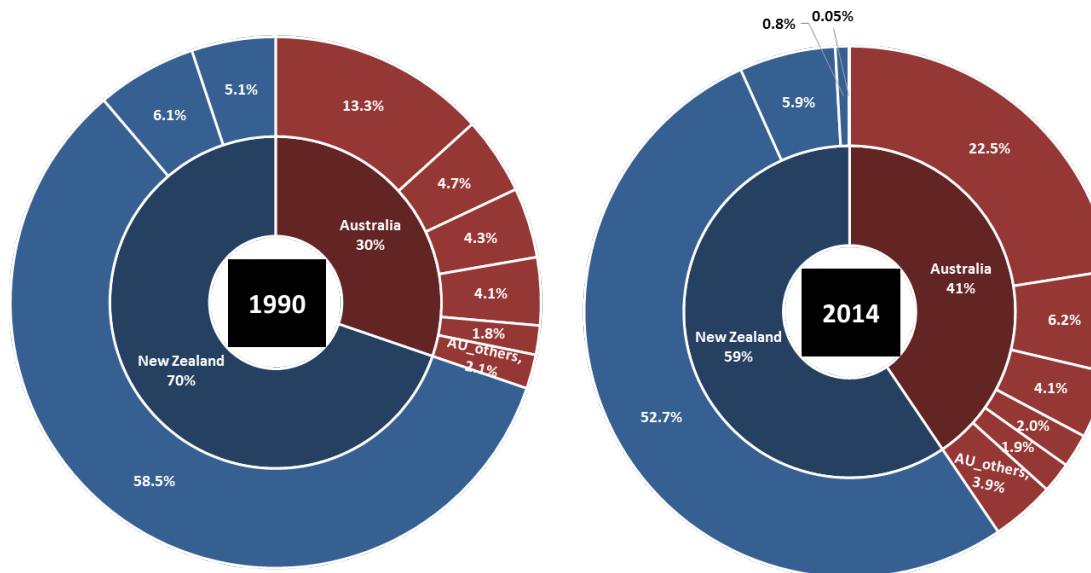
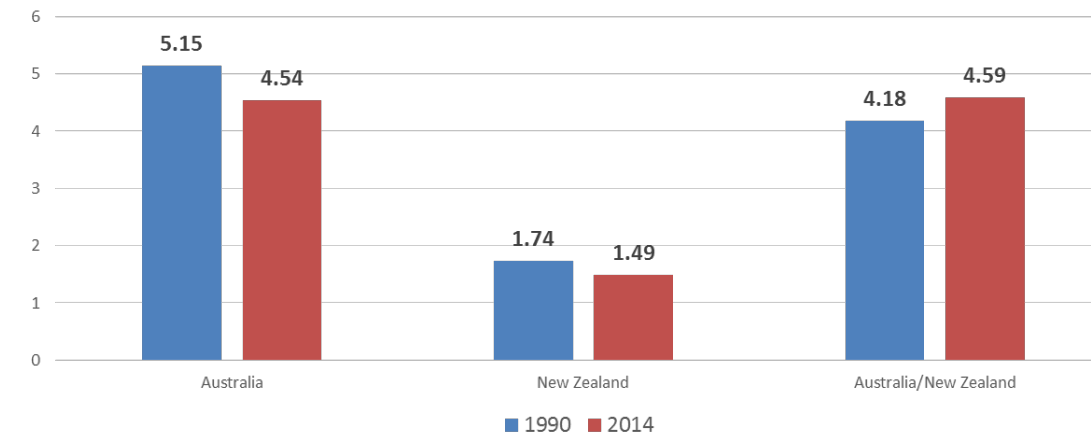
Regional species diversification may not reflect the average or sum of species diversification of countries in the region: the case of Europe

Aquaculture species diversification in Europe: 1990 - 2014



Regional species diversification may not reflect average species diversification of countries in the region: the case of Australia/New Zealand

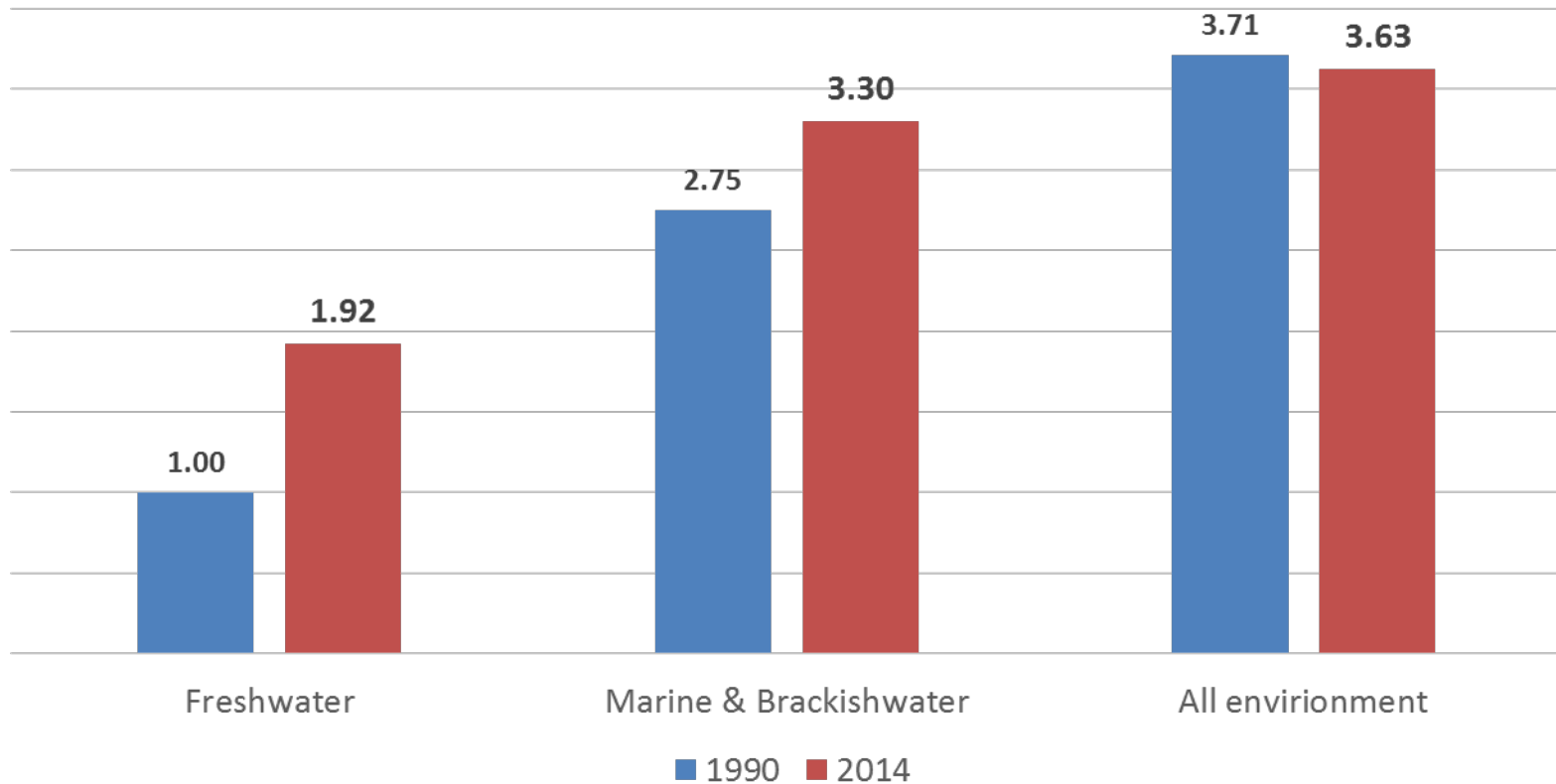
Aquaculture species diversity in Australia and New Zealand:
1990 vs. 2014



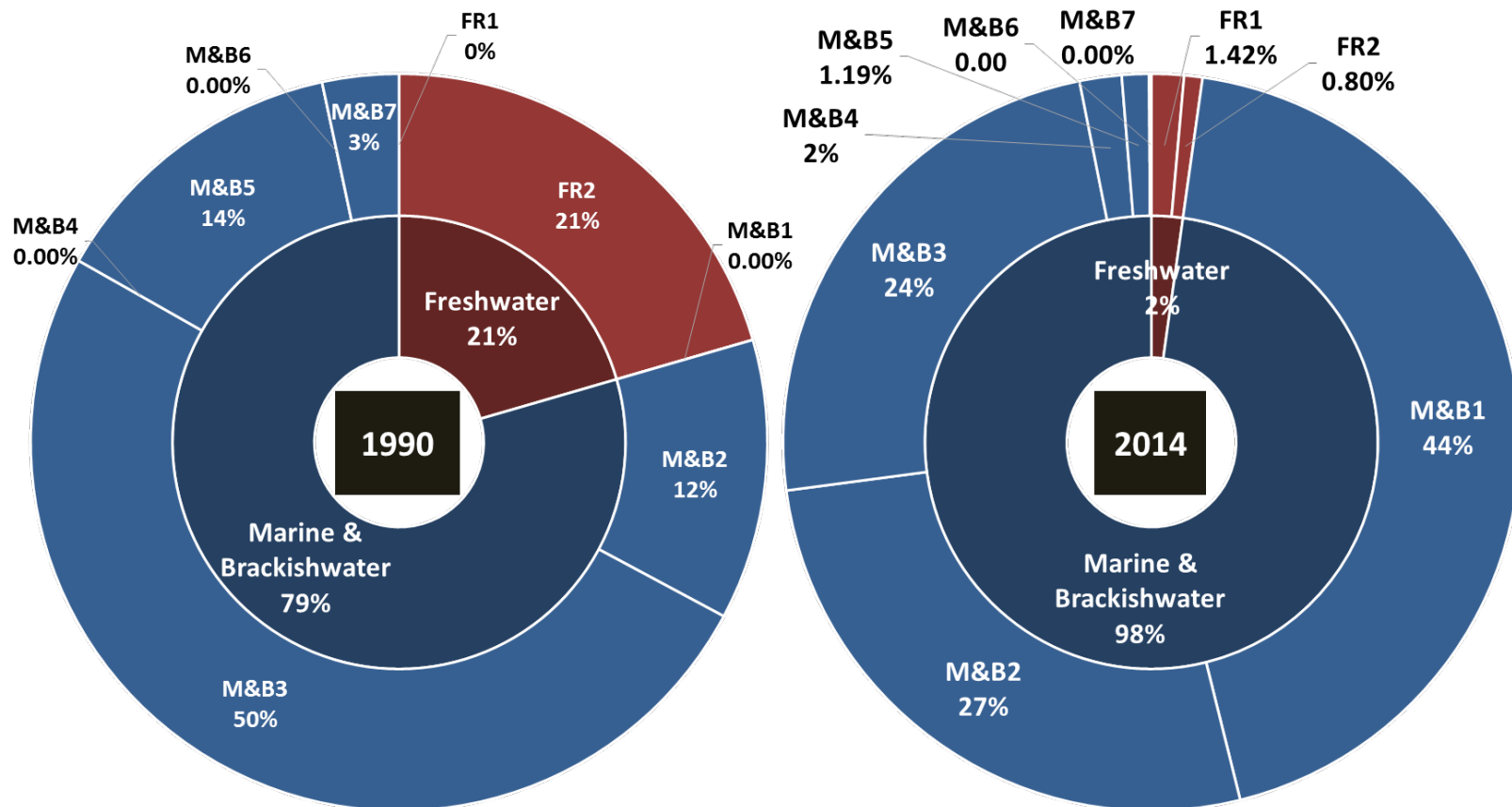
Farming environments

Species diversification in all environments may not reflect the average or sum of species diversification in different environments

Species diversification in Viet Nam's shellfish aquaculture: 1990 vs. 2014



Species diversification in Viet Nam's shellfish aquaculture



FR = Freshwater; M&B = Marine & Brackishwater

FR1= Freshwater molluscs nei (Mollusca); FR2= Giant river prawn (*Macrobrachium rosenbergii*);

M&B1= Whiteleg shrimp (*Penaeus vannamei*); M&B2= Marine molluscs nei; M&B3= Giant tiger prawn;

M&B4= Indo-Pacific swamp crab; M&B5= Banana prawn; M&B6= Tropical spiny lobsters nei

Species scope

Examples of 328 species groups

WAPI species or species group
Aquatic product = Seafood + Miscellaneous aquatic animal products + Aquatic plants
Seafood = Fish + Miscellaneous aquatic animals
Fish = Finfish + Shellfish
Shellfish = Crustaceans + Molluscs
Finfish
Freshwater fishes
Diadromous fishes
Marine fishes
Crustaceans
Marine crustaceans
Freshwater crustaceans
Molluscs
Marine molluscs
Freshwater molluscs
Miscellaneous aquatic animals
Miscellaneous aquatic invertebrates
Aquatic tetrapoda vertebrates
Miscellaneous aquatic animal products
Marine aquatic animal products
Freshwater aquatic animal products
Aquatic plants
Macroalgae
Microalgae
Aquatic plants nei

Freshwater fishes

[Carp and minnows \(Cyprinidae\)](#)

[Tilapia and other cichlids \(Cichlidae\)](#)

[Catfishes \(Siluriformes\)](#)

[Freshwater perch-like fishes \(Percoidea, freshwater\)](#)

[Snakeheads \(Channidae\)](#)

[Characins \(Characiformes\)](#)

[Swamp-eels \(Synbranchidae\)](#)

[Loaches \(Cobitidae\)](#)

[Labyrinth fish \(Anabantoidae\)](#)

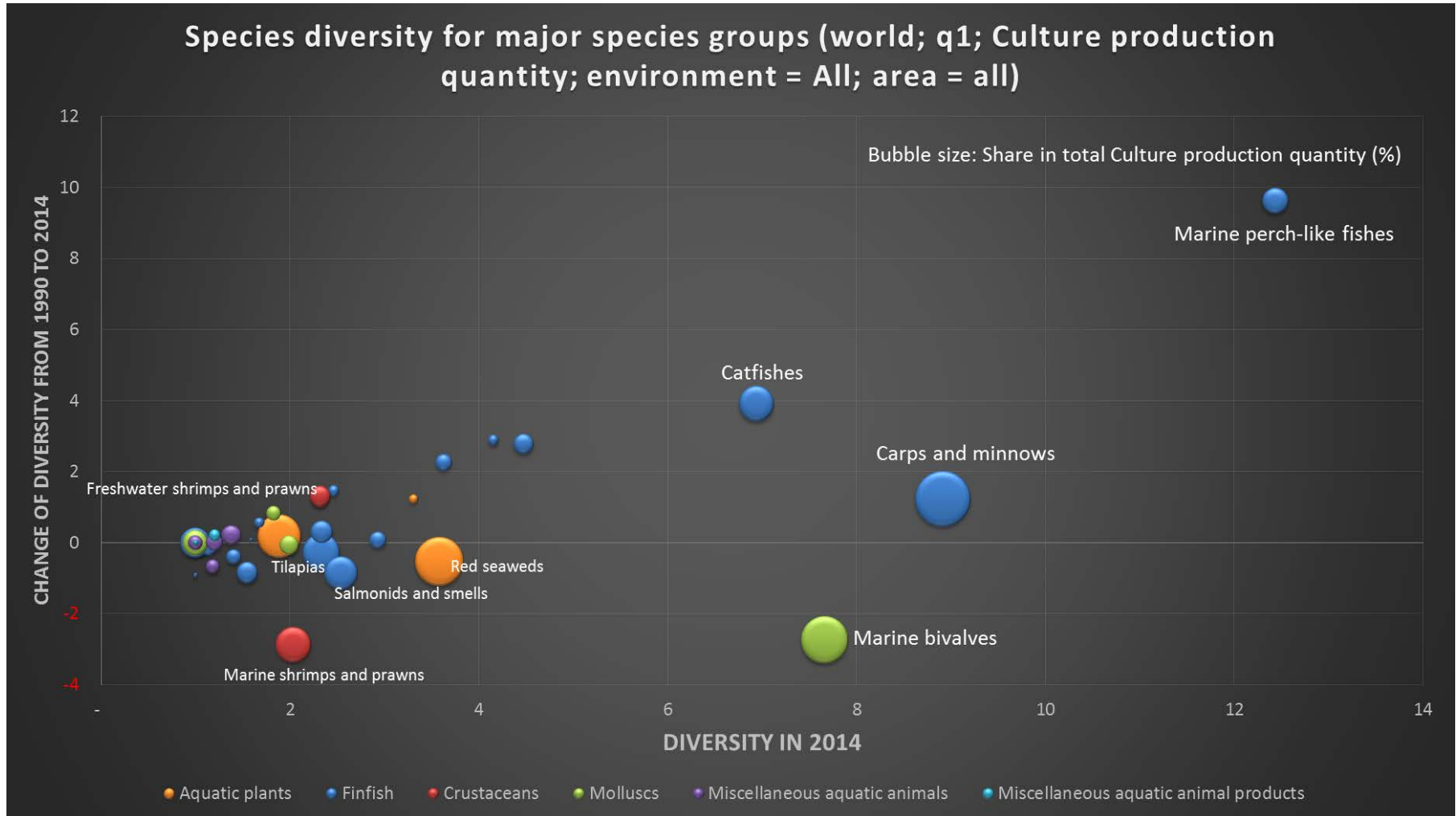
[Bony tongues \(Osteoglossiformes\)](#)

[Freshwater gobies and sleepers \(Gobioidae, freshwater\)](#)

[Miscellaneous freshwater fishes](#)

[Freshwater fishes nei](#)

Species diversity for major aquaculture species groups



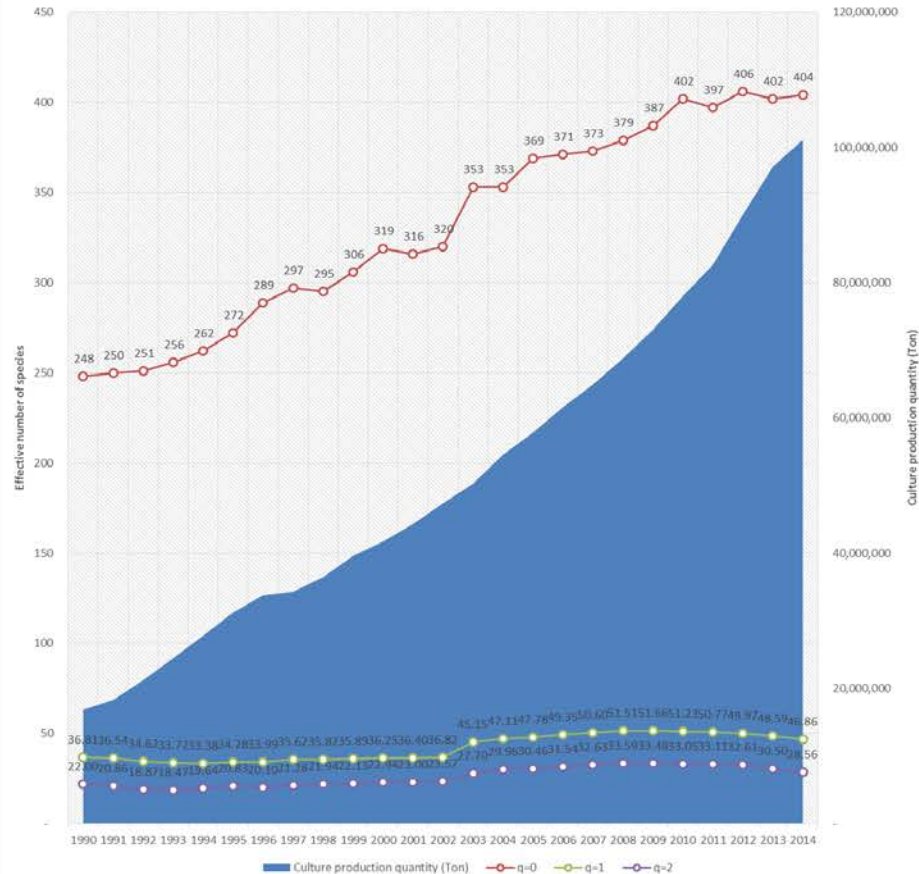
Year: 1990-2014; Area = All; Environment = All; Scope = Aquatic products; Diversity measure (q = 1)

Part II: Salient patterns or stylized facts of species diversification in aquaculture

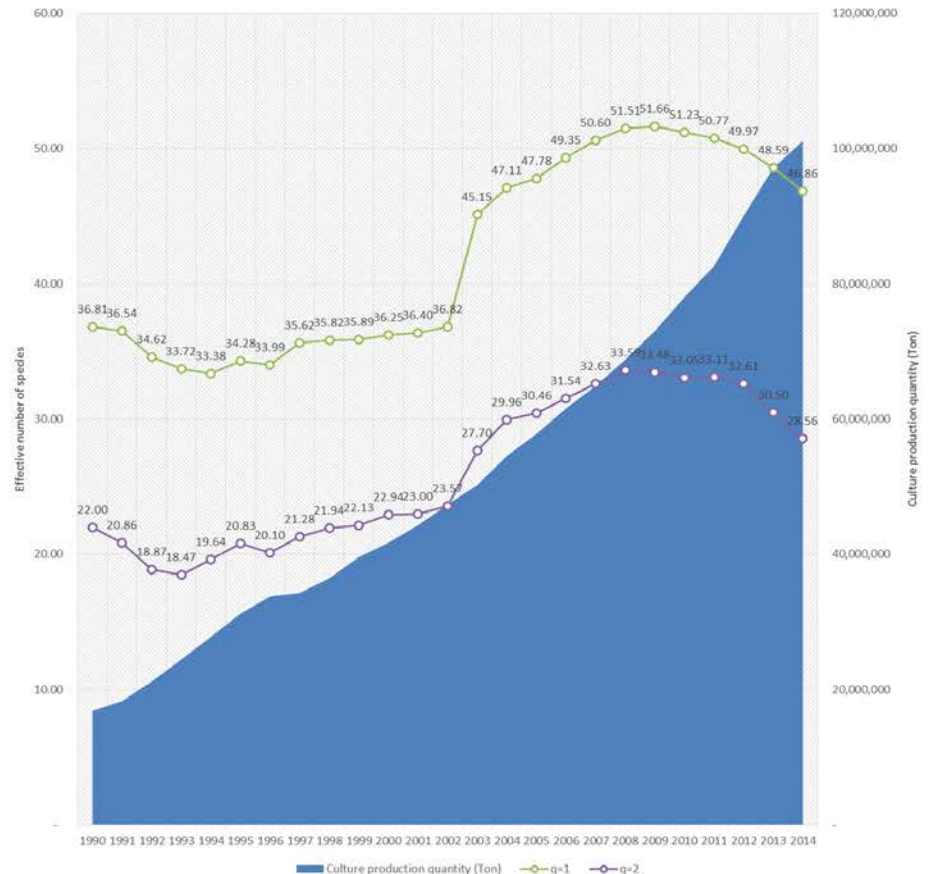
1990 to 2014: More species
diversified global aquaculture

More species diversified aquaculture for the world as a whole

World: aquaculture diversification during 1990-2014 (scope = Aquatic products; environment = All; area= all; measured by Culture production quantity)



World: aquaculture diversification during 1990-2014 (scope = Aquatic products; environment = All; area= all; measured by Culture production quantity)



More species diversified aquaculture for most of species scopes

Changes in species diversity in global aquaculture from 1990 to 2014

Scope	World including China				World without China			
	Number of countries		Share of world production (%)		Number of countries		Share of world production (%)	
	Diversity increase	Diversity decrease	Diversity increase	Diversity decrease	Diversity increase	Diversity decrease	Diversity increase	Diversity decrease
Aquatic products	104	48	73	27	103	48	34	65
Seafood	102	48	87	13	101	48	65	35
Fish	101	49	86	14	100	49	64	36
Finfish	93	46	83	17	92	46	62	38
Freshwater fishes	79	40	85	15	78	40	62	37
Diadromous fishes	30	41	43	57	29	41	38	61
Marine fishes	24	6	85	6	23	6	71	13
Shellfish	28	41	84	15	27	41	36	63
Crustaceans	11	35	67	33	10	35	21	78
Molluscs	20	23	90	10	19	23	41	58
Miscellaneous aquatic animals	4	3	94	3	3	3	9	47
Miscellaneous aquatic animal products	0	1	.	0	0	1	.	0
Aquatic plants	7	9	90	9	6	9	81	17

Area = All; Environment = All; Production measure = Quantity; Diversity measure (q =1)

More species diversified aquaculture in most farming environments

Changes in species diversity in global aquaculture from 1990 to 2014: perspective from different scopes

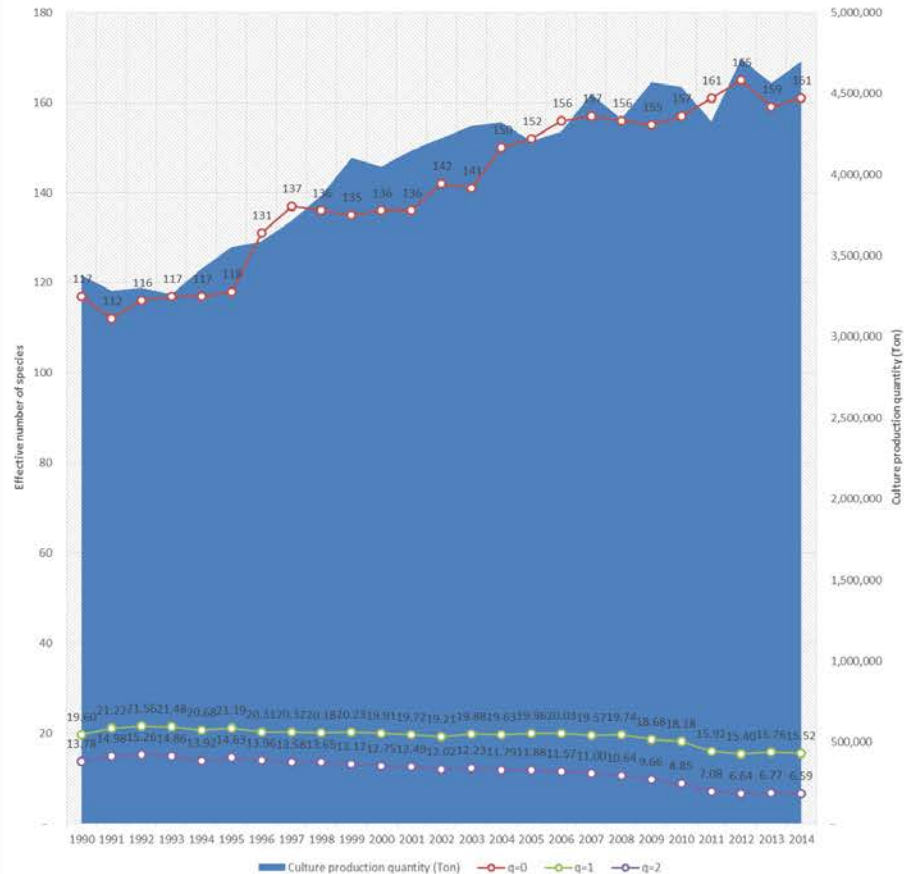
Environment	Measure	Scope = Aquatic products		Scope = Fish	
		Increased diversity	Decreased diversity	Increased diversity	Decreased diversity
All environment	Number of countries	104	48	101	49
	Share of world production (%)	73	27	86	14
Freshwater	Number of countries	88	12	87	13
	Share of world production (%)	91	43	88	46
Marine & brackishwater	Number of countries	51	35	48	33
	Share of world production (%)	69	31	81	18
Marine	Number of countries	34	27	33	21
	Share of world production (%)	91	9	91	9
Brackishwater	Number of countries	18	25	17	26
	Share of world production (%)	47	53	55	44

Country/region = World; Area = All; Environment = All;
 Production measure = Quantity; Diversity measure (q =1)

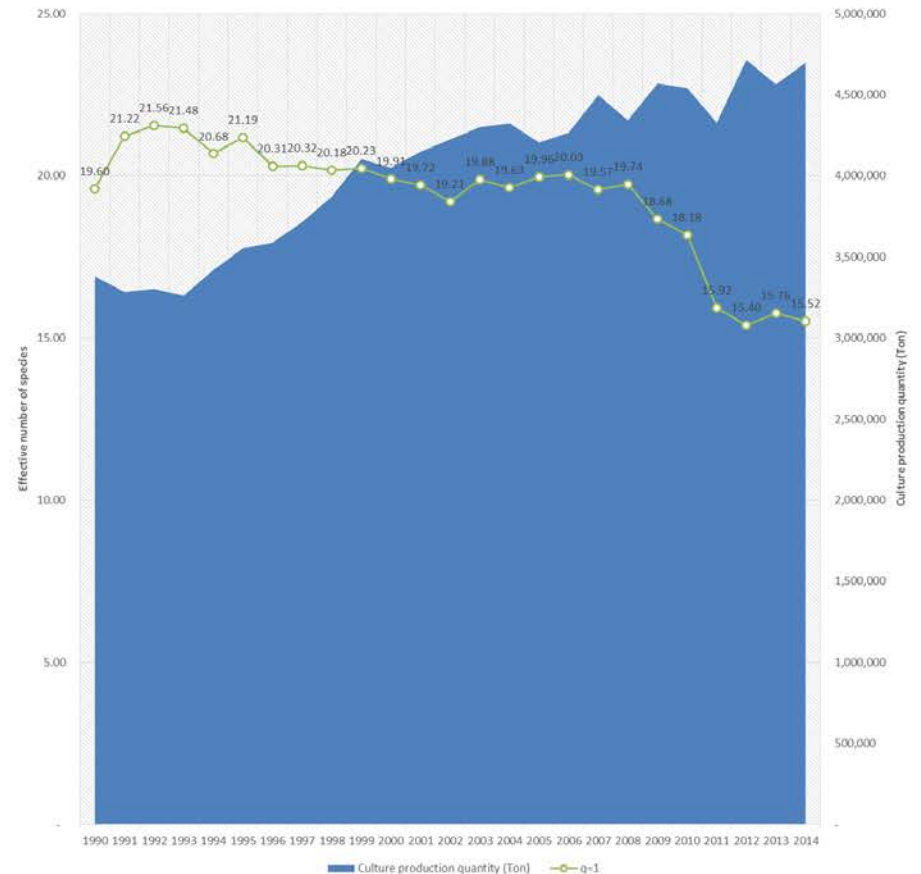
Aquaculture species diversification: regional perspective

Less species diversified aquaculture in developed regions

Aquaculture diversification during 1990-2014 (Country/area = Developed regions; scope = Aquatic products; environment = All; area= all; measured by Culture production quantity)

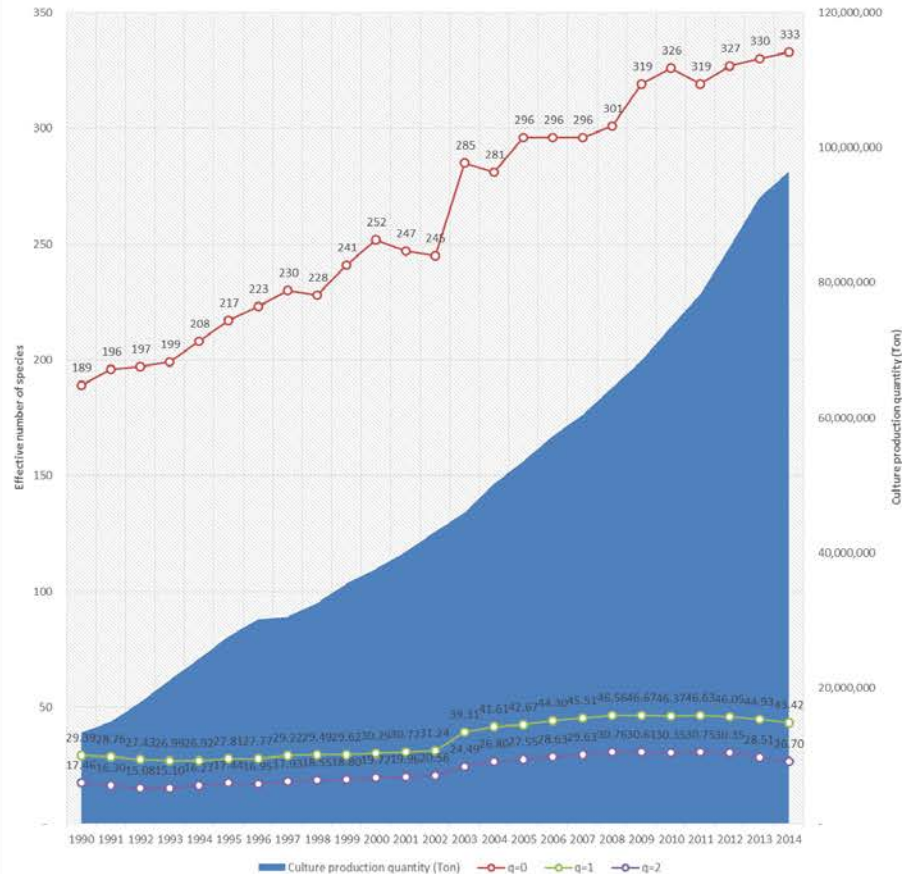


Aquaculture diversification during 1990-2014 (Country/area = Developed regions; scope = Aquatic products; environment = All; area= all; measured by Culture production quantity)

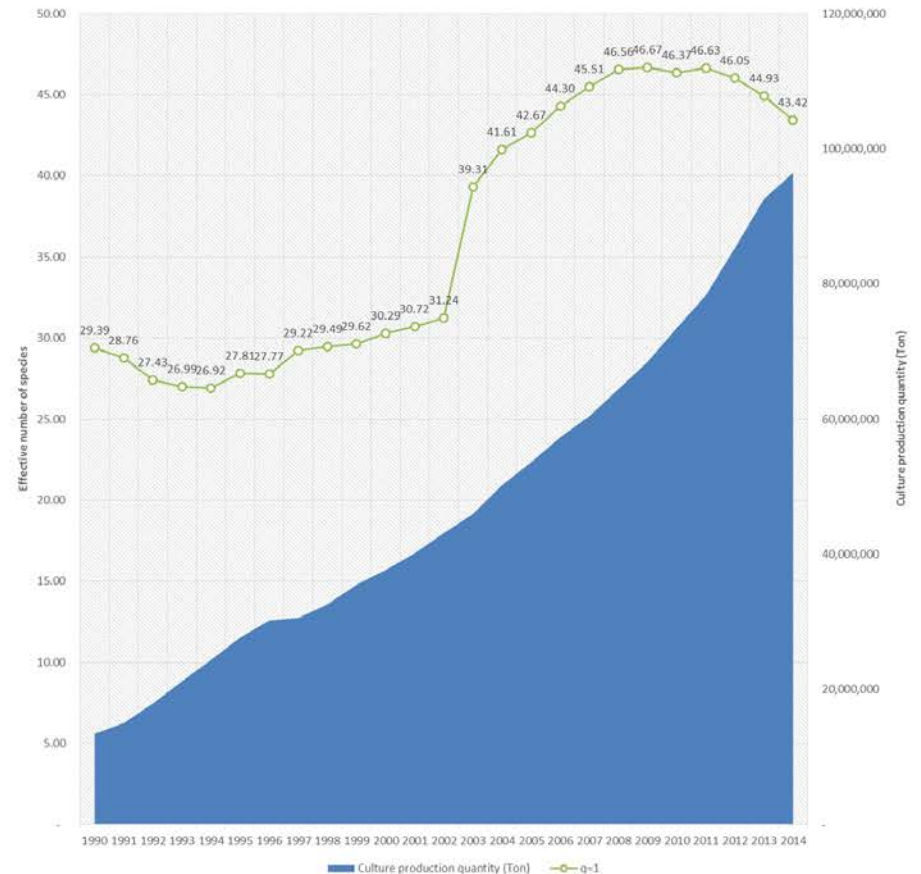


More species diversified aquaculture in developing regions

Aquaculture diversification during 1990-2014 (Country/area = Developing regions; scope = Aquatic products; environment = All; area = all; measured by Culture production quantity)

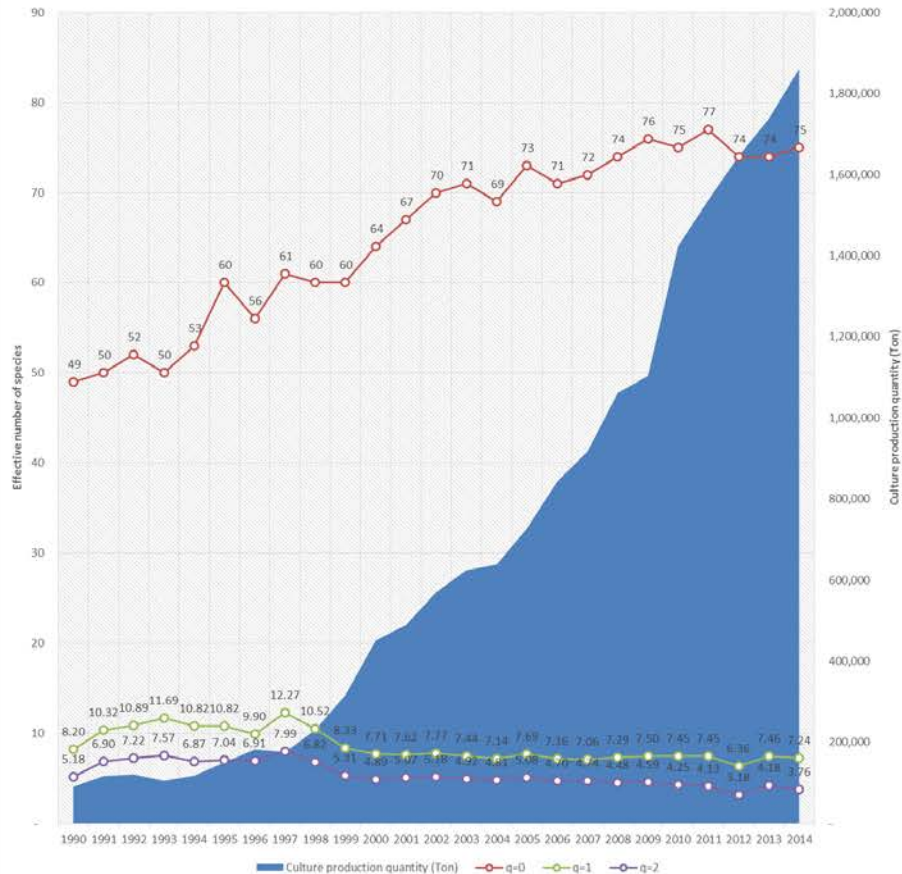


Aquaculture diversification during 1990-2014 (Country/area = Developing regions; scope = Aquatic products; environment = All; area = all; measured by Culture production quantity)

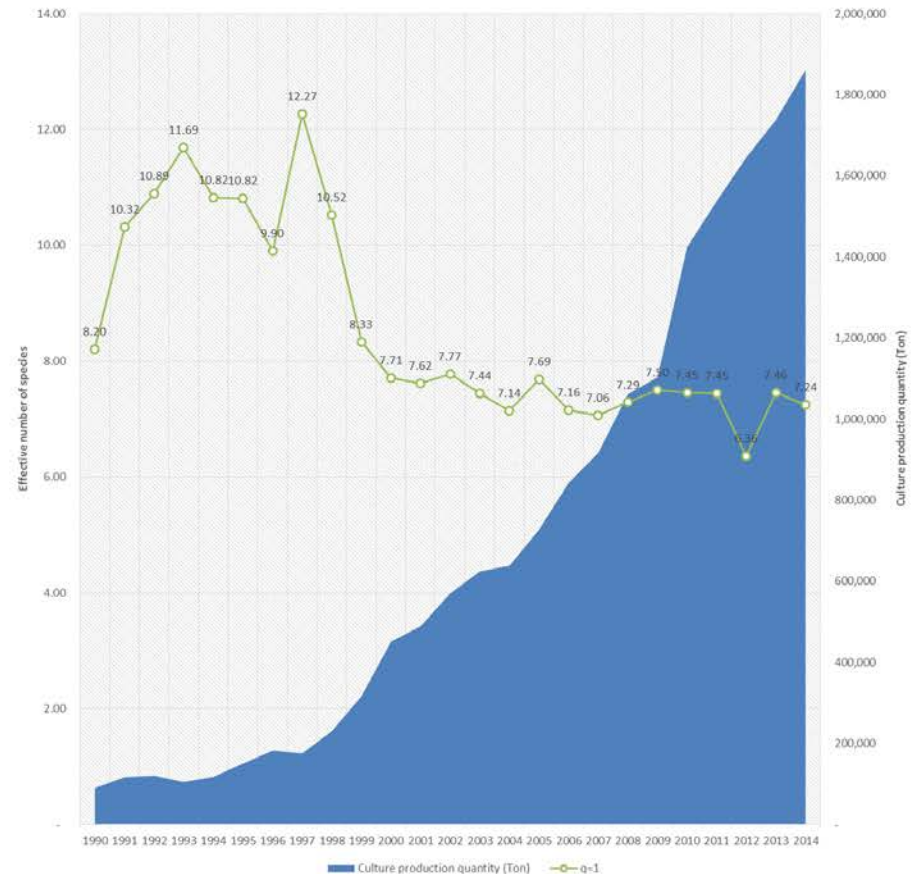


Less species diversified aquaculture in Africa

Aquaculture diversification during 1990-2014 (Country/area = Africa;
scope = Aquatic products; environment = All; area= all; measured by
Culture production quantity)



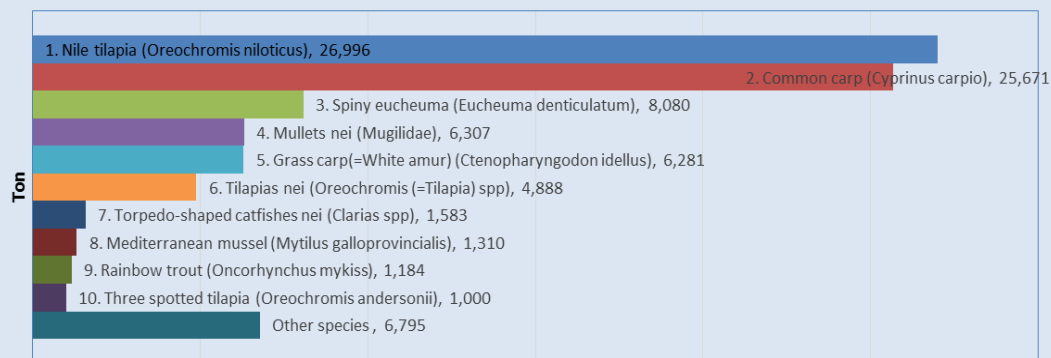
Aquaculture diversification during 1990-2014 (Country/area = Africa;
scope = Aquatic products; environment = All; area= all; measured by
Culture production quantity)



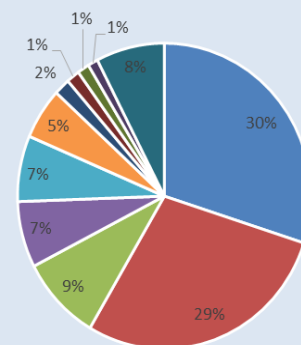
Top-10 species in Africa: 1990 vs. 2014

Diversity in 1990 = 8.2

Africa in 1990: Top-10 species groups under WAPI FishSTAT species grouping

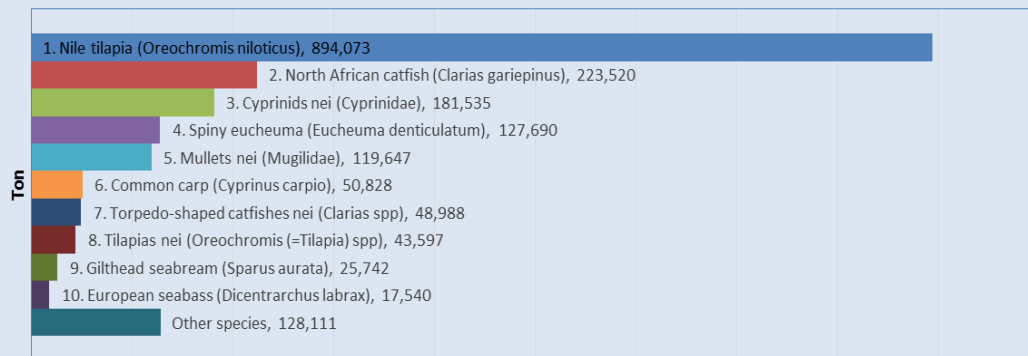


Share in total aquatic products (%)

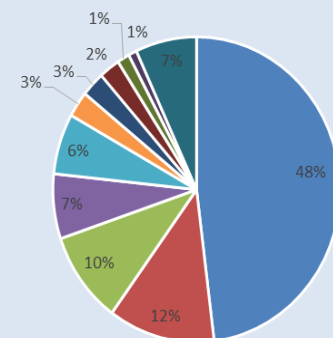


Diversity in 2014 = 7.2

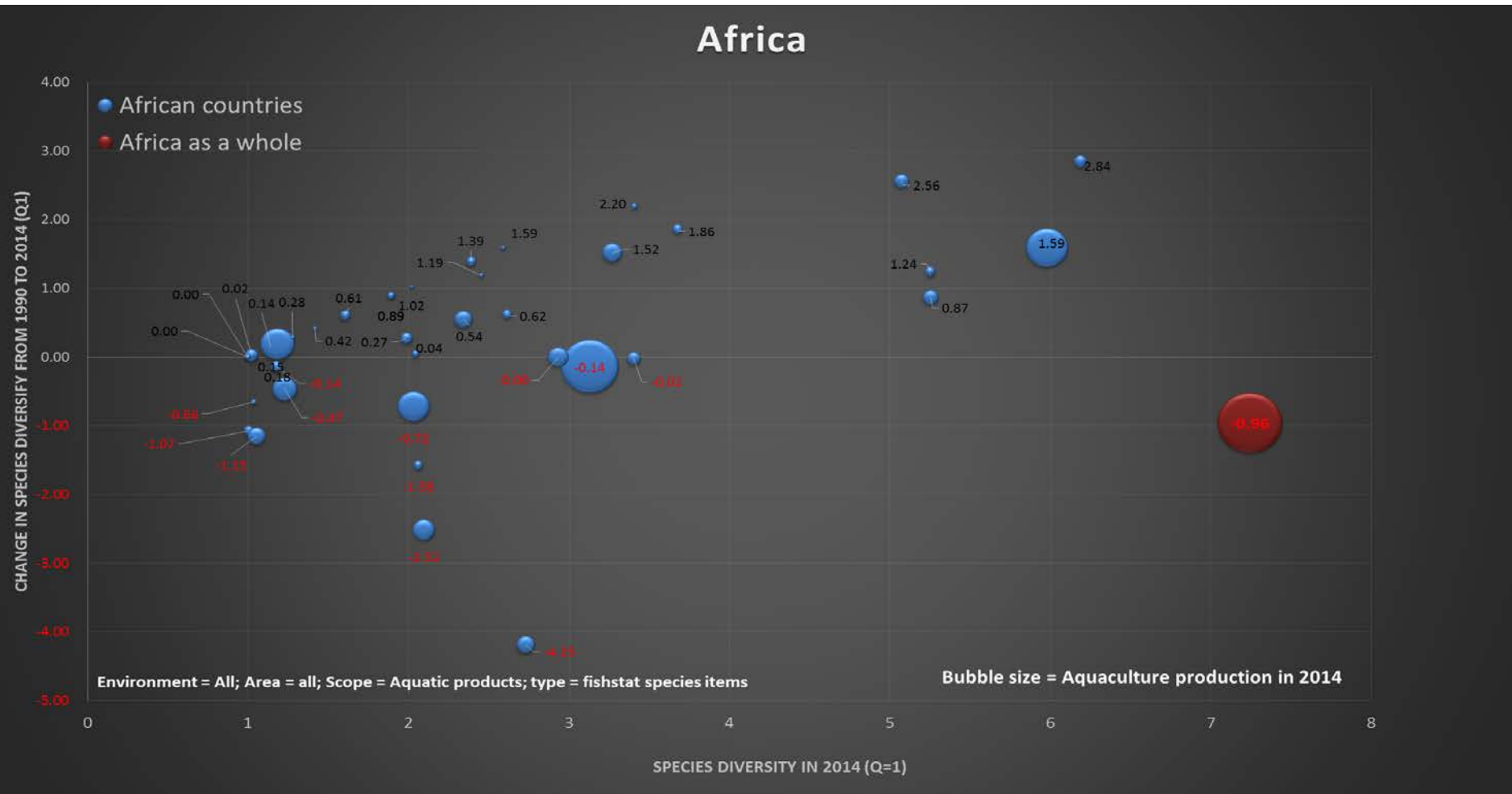
Africa in 2014: Top-10 species groups under WAPI FishSTAT species grouping



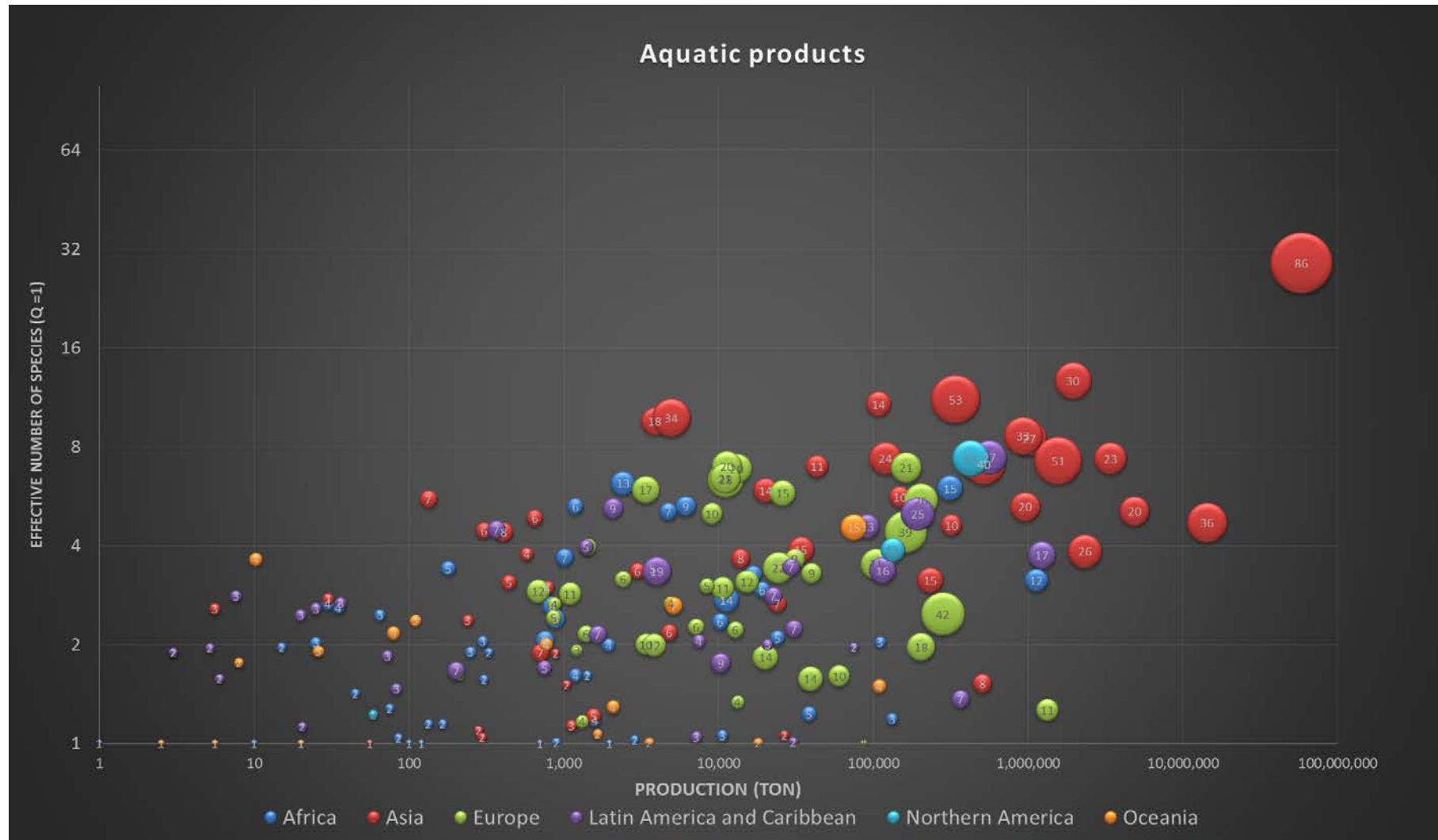
Share in total aquatic products (%)



Aquaculture species diversification in Africa

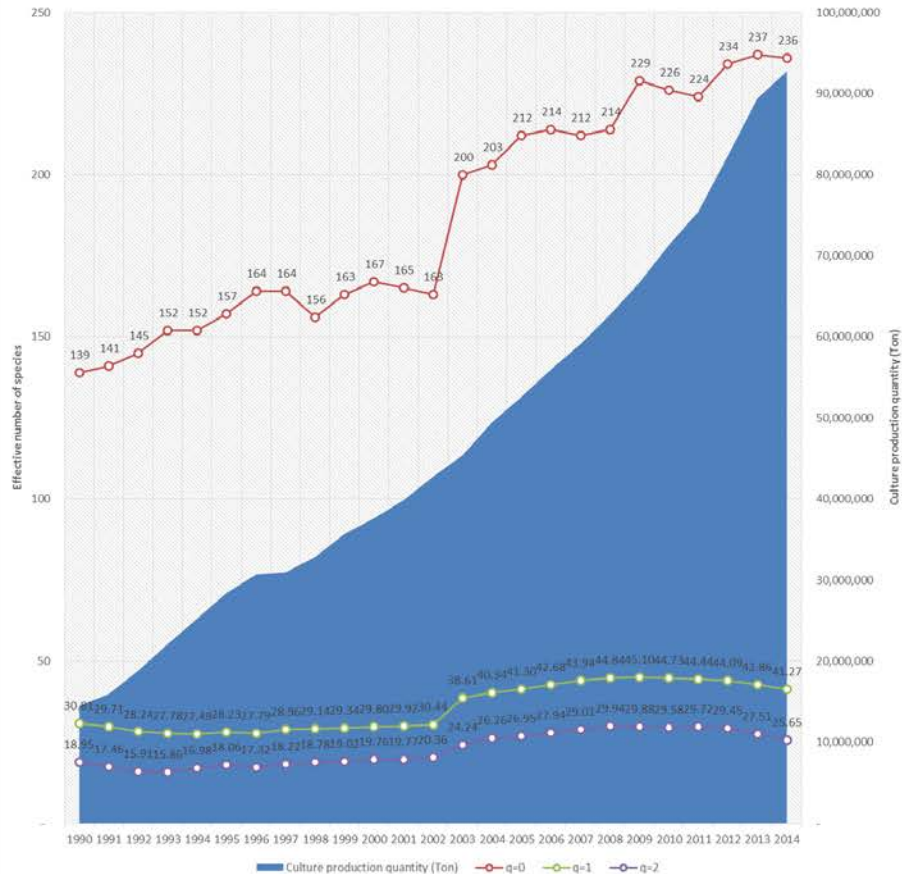


Asia: the most diversified region

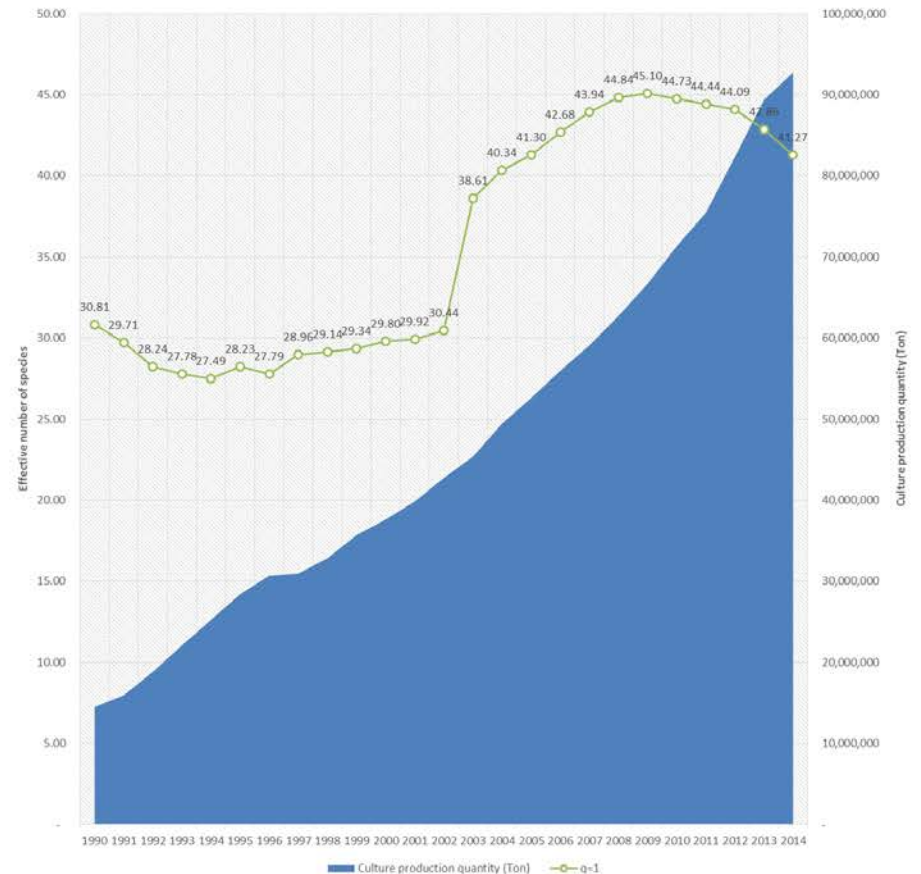


More species diversified aquaculture in Asia

Aquaculture diversification during 1990-2014 (Country/area = Asia;
scope = Aquatic products; environment = All; area= all; measured by
Culture production quantity)



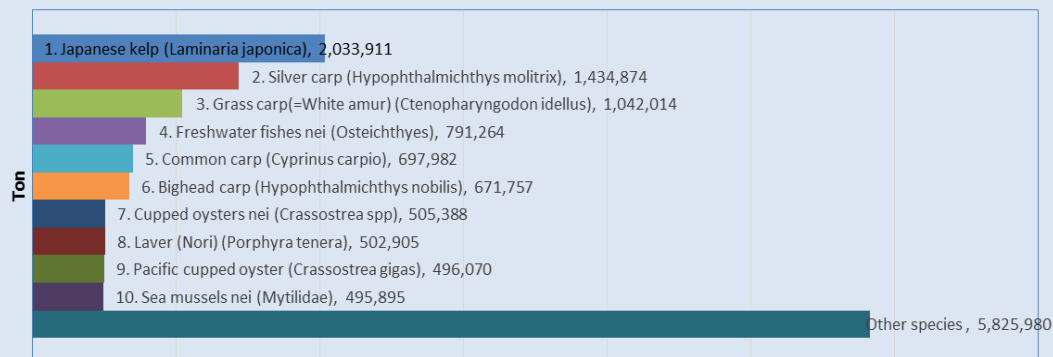
Aquaculture diversification during 1990-2014 (Country/area = Asia;
scope = Aquatic products; environment = All; area= all; measured by
Culture production quantity)



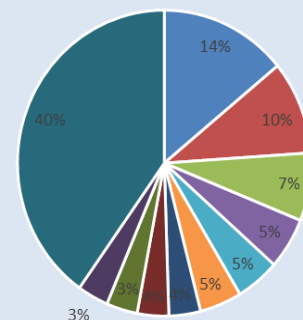
Top-10 species in Asia: 1990 vs. 2014

Diversity in 1990 = 30.8

Asia in 1990: Top-10 species groups under WAPI FishSTAT species grouping

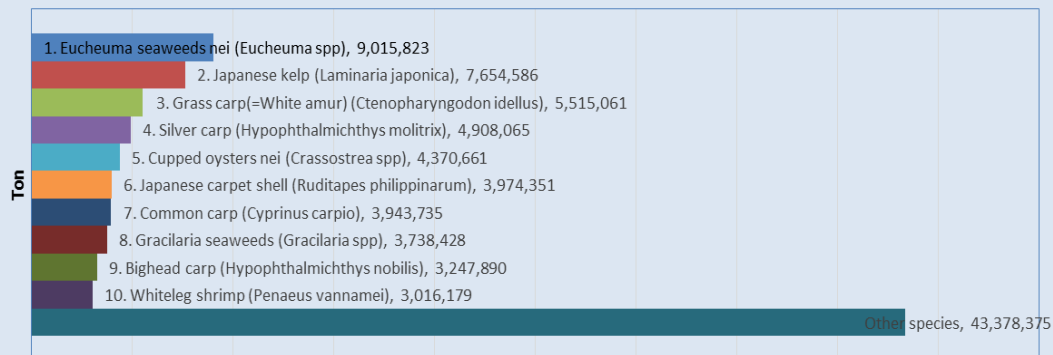


Share in total aquatic products (%)

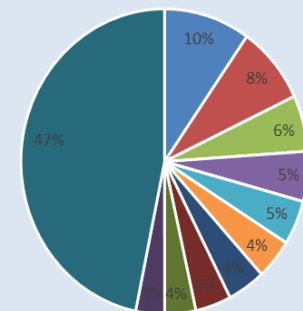


Diversity in 2014 = 41.3

Asia in 2014: Top-10 species groups under WAPI FishSTAT species grouping

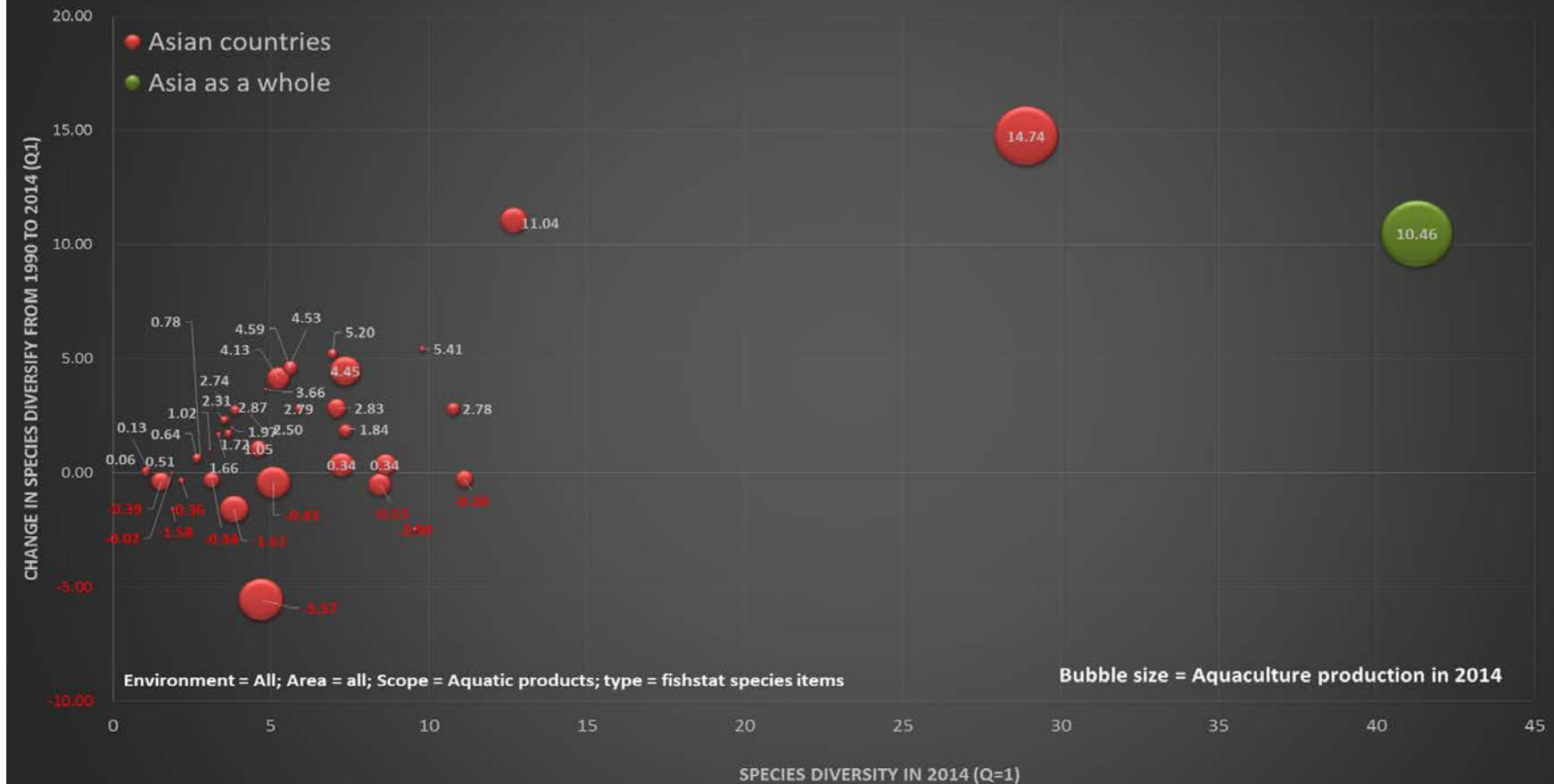


Share in total aquatic products (%)



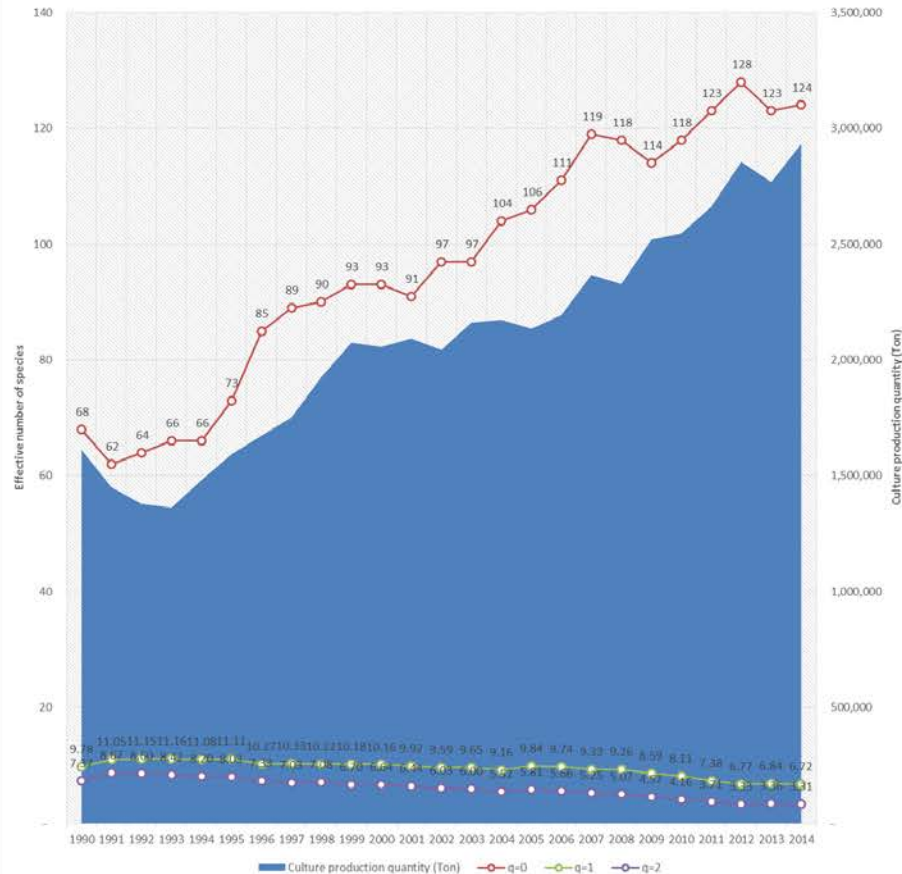
Asian countries

Asia

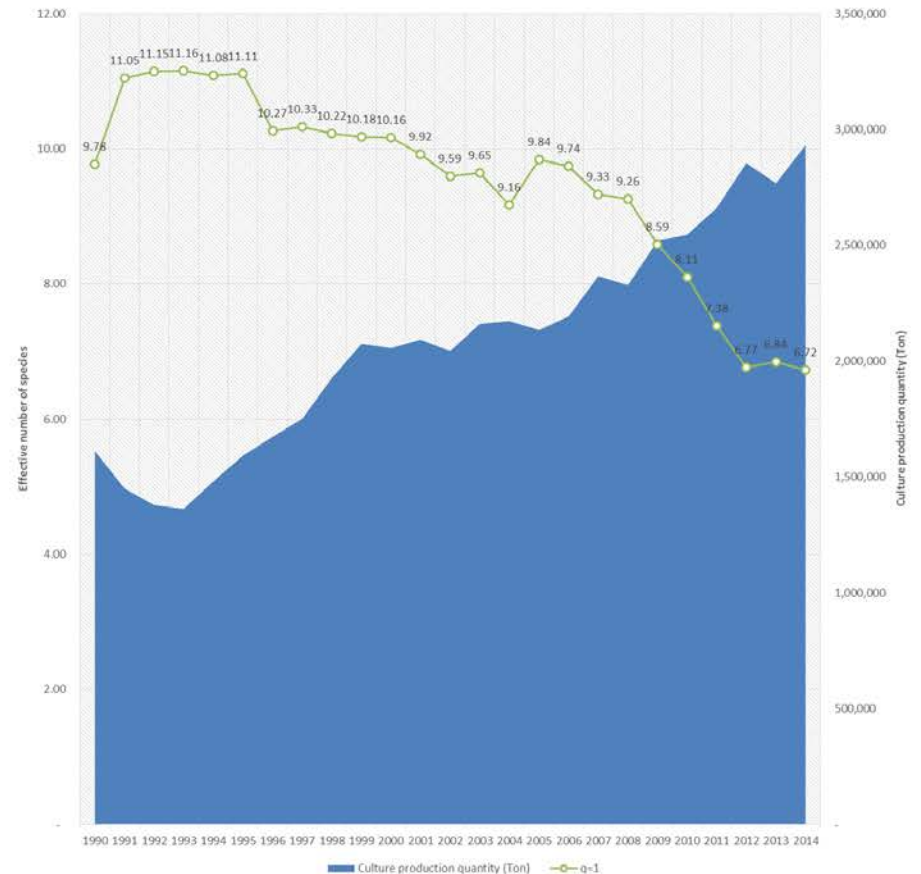


More species diversified aquaculture in Europe

Aquaculture diversification during 1990-2014 (Country/area = Europe;
scope = Aquatic products; environment = All; area= all; measured by
Culture production quantity)



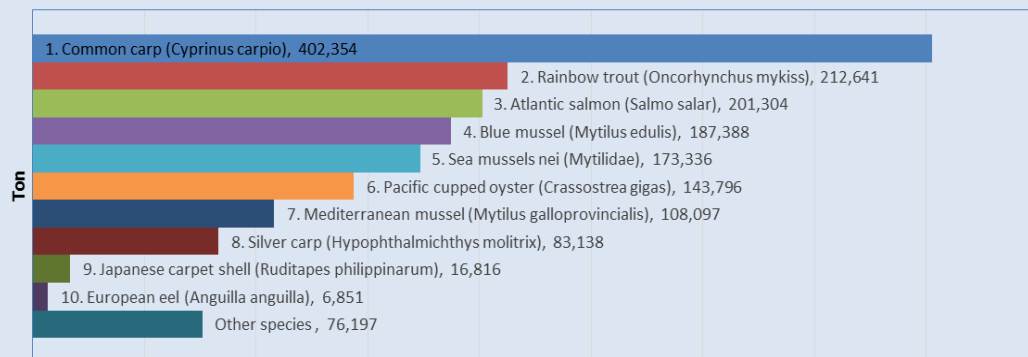
Aquaculture diversification during 1990-2014 (Country/area = Europe;
scope = Aquatic products; environment = All; area= all; measured by
Culture production quantity)



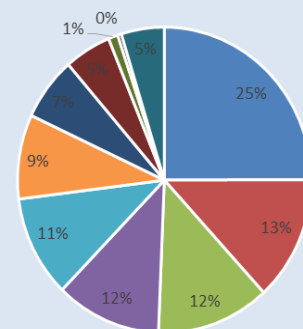
Top-10 species in Europe: 1990 vs. 2014

Diversity in 1990 = 9.8

Europe in 1990: Top-10 species groups under WAPI FishSTAT species grouping

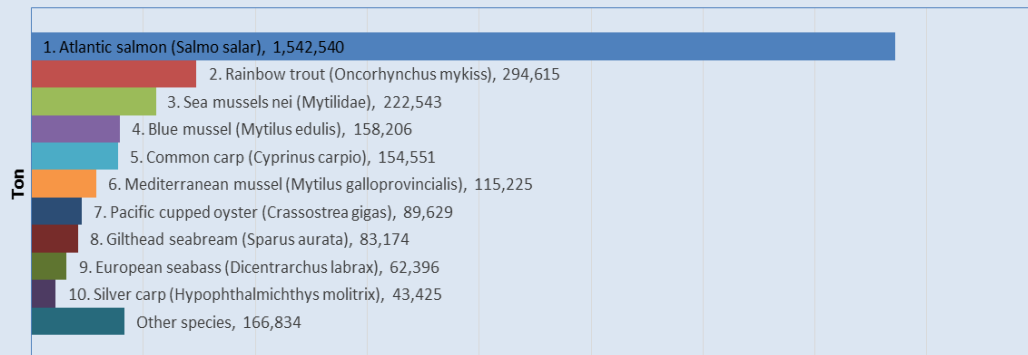


Share in total aquatic products (%)

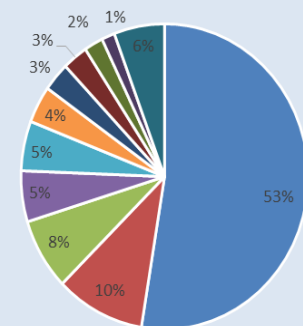


Diversity in 2014 = 6.7

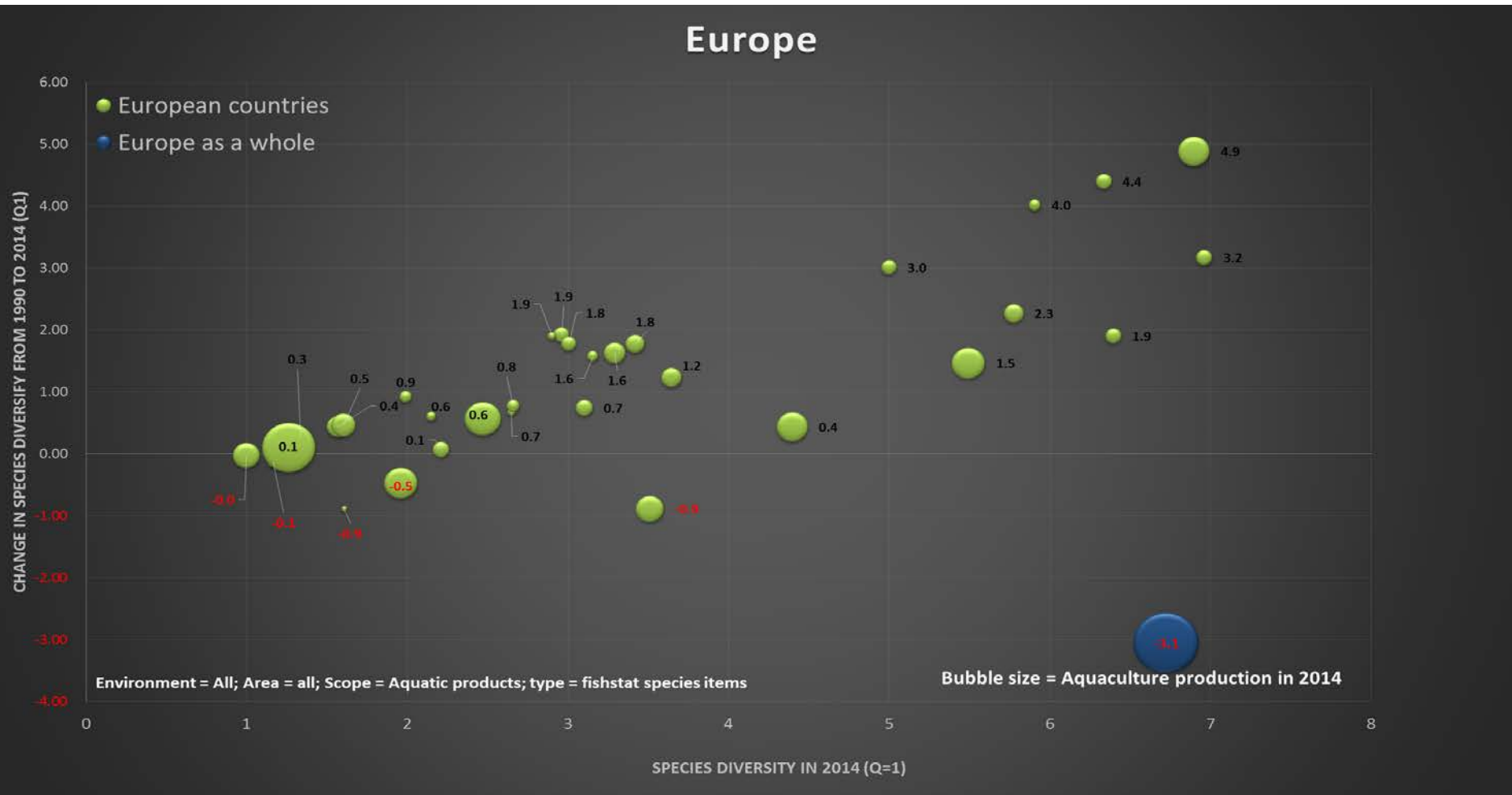
Europe in 2014: Top-10 species groups under WAPI FishSTAT species grouping



Share in total aquatic products (%)

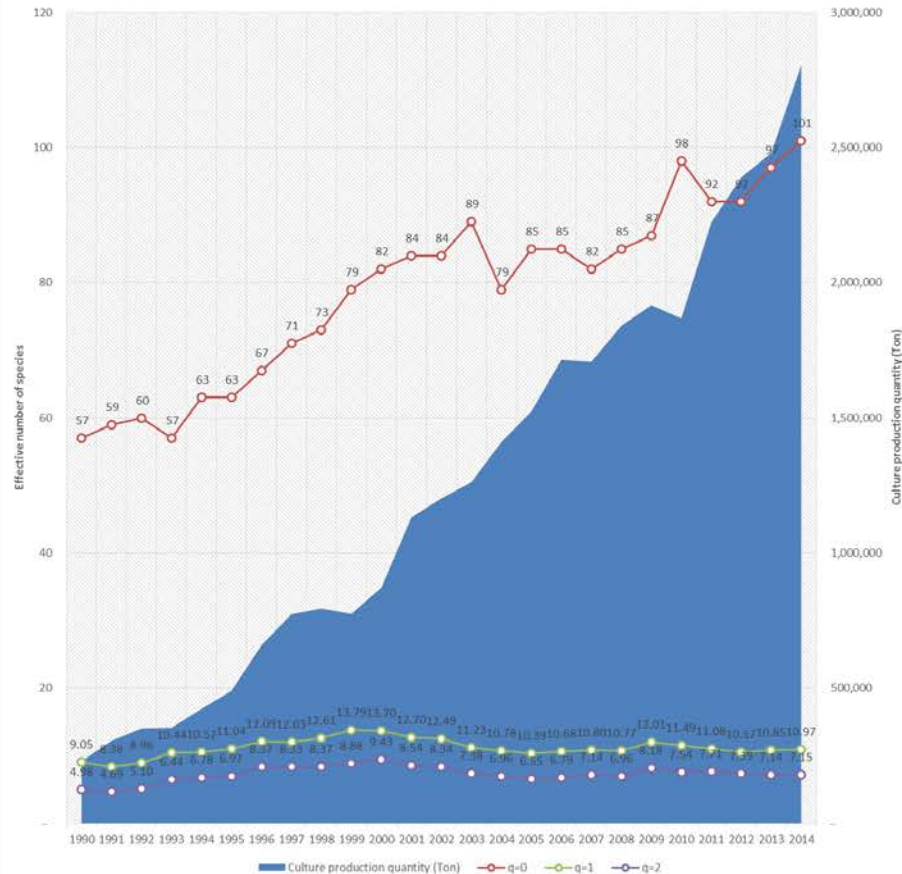


European countries

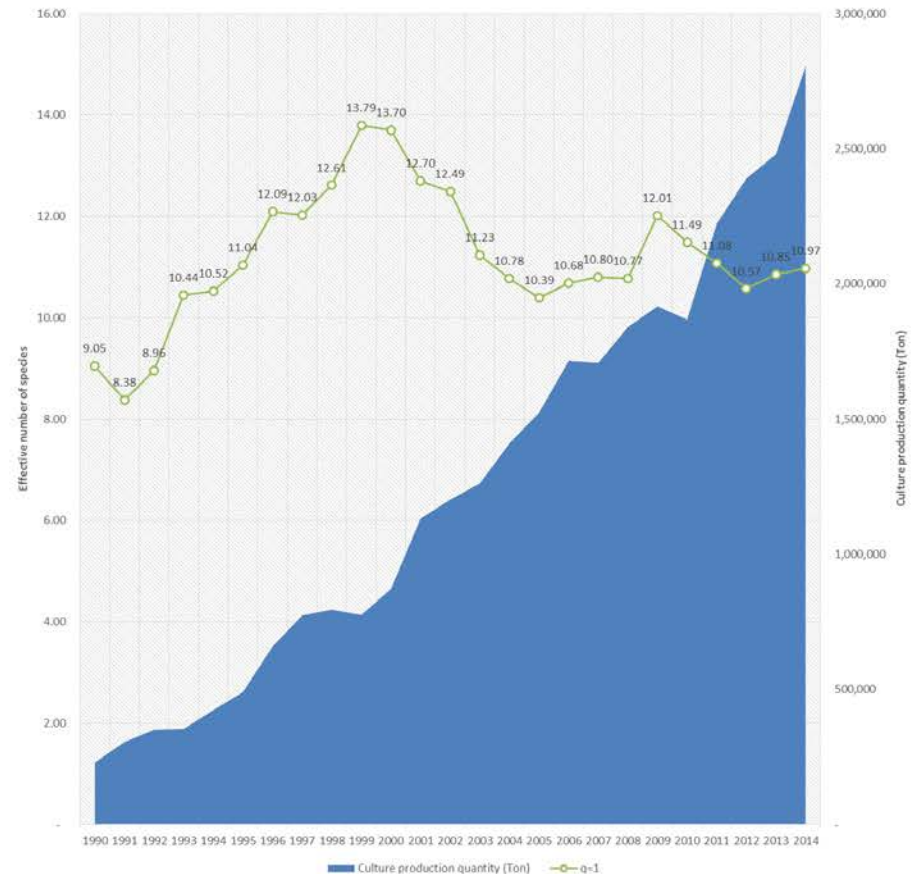


More species diversified aquaculture in Latin America and Caribbean

Aquaculture diversification during 1990-2014 (Country/area = Latin America and Caribbean; scope = Aquatic products; environment = All; area= all; measured by Culture production quantity)



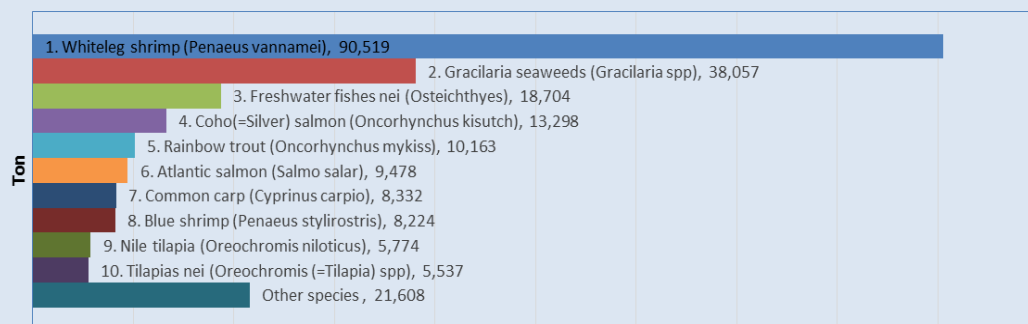
Aquaculture diversification during 1990-2014 (Country/area = Latin America and Caribbean; scope = Aquatic products; environment = All; area= all; measured by Culture production quantity)



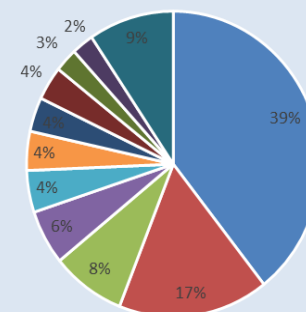
Top-10 species in LAC: 1990 vs. 2014

Diversity in 1990 = 9.1

Latin America and Caribbean in 1990: Top-10 species groups under WAPI
FishSTAT species grouping

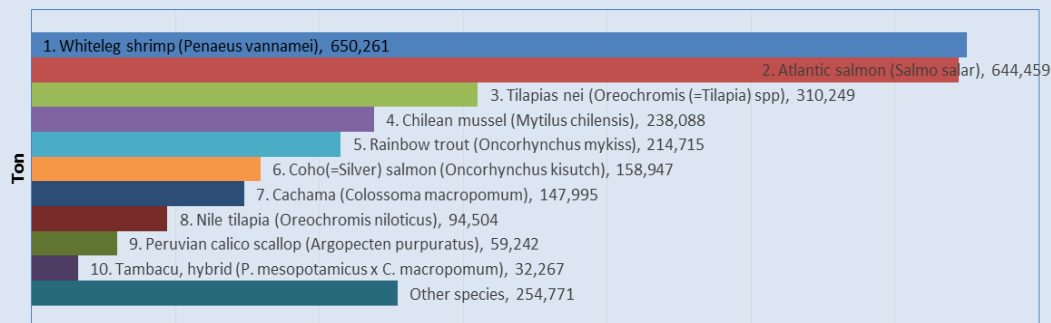


Share in total aquatic products (%)

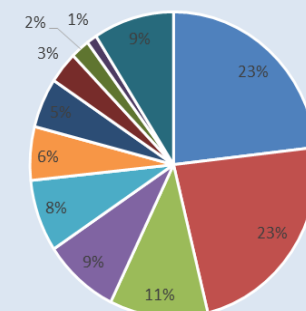


Diversity in 2014 = 11.0

Latin America and Caribbean in 2014: Top-10 species groups under WAPI
FishSTAT species grouping

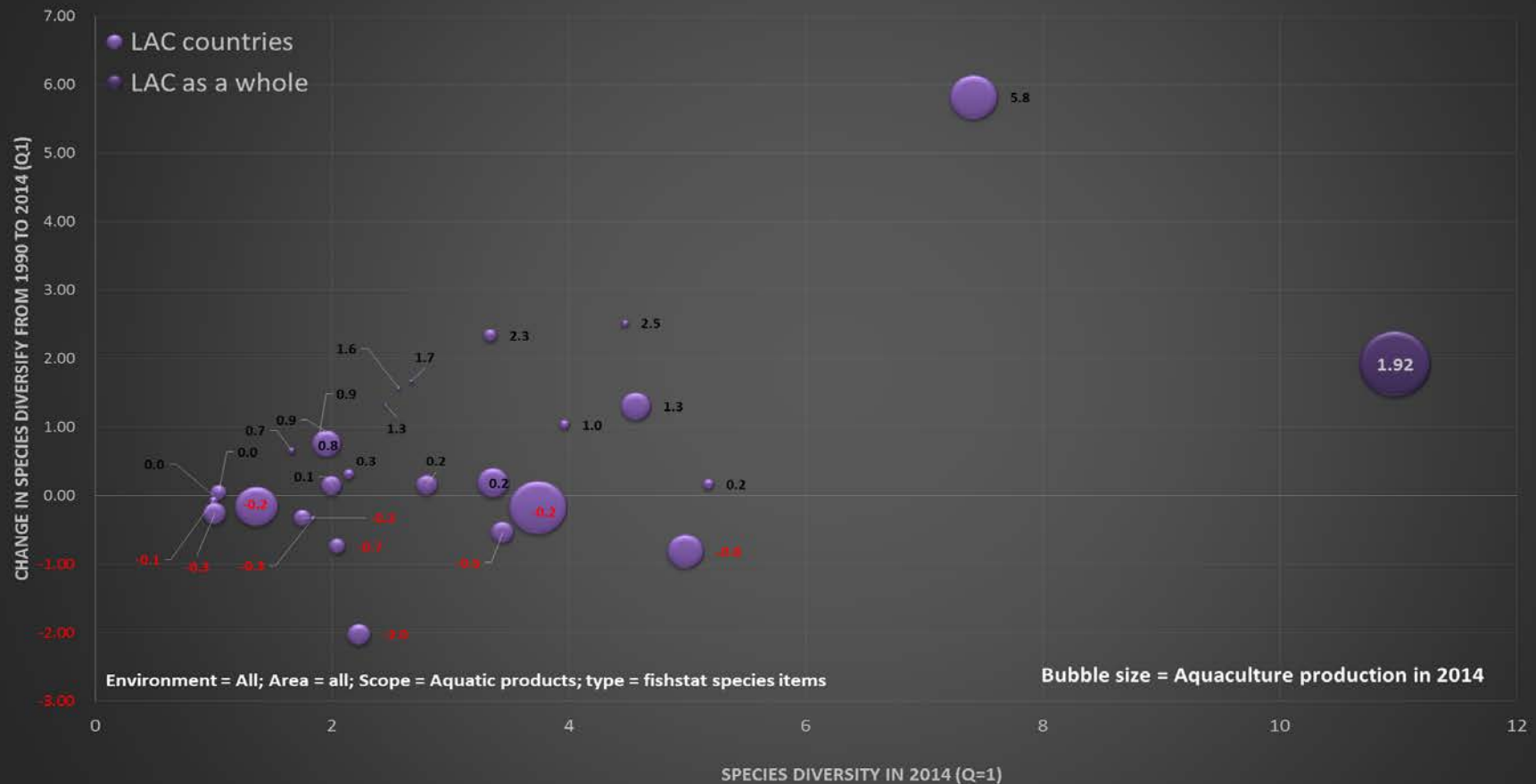


Share in total aquatic products (%)



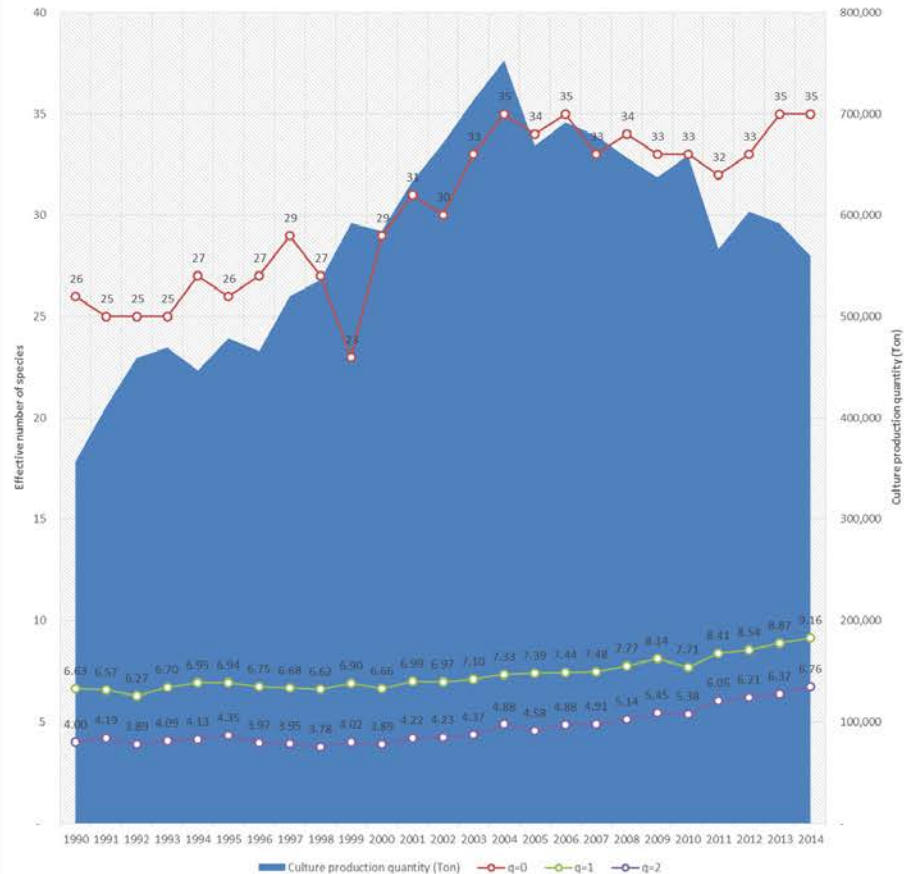
LAC countries

Latin America and Caribbean

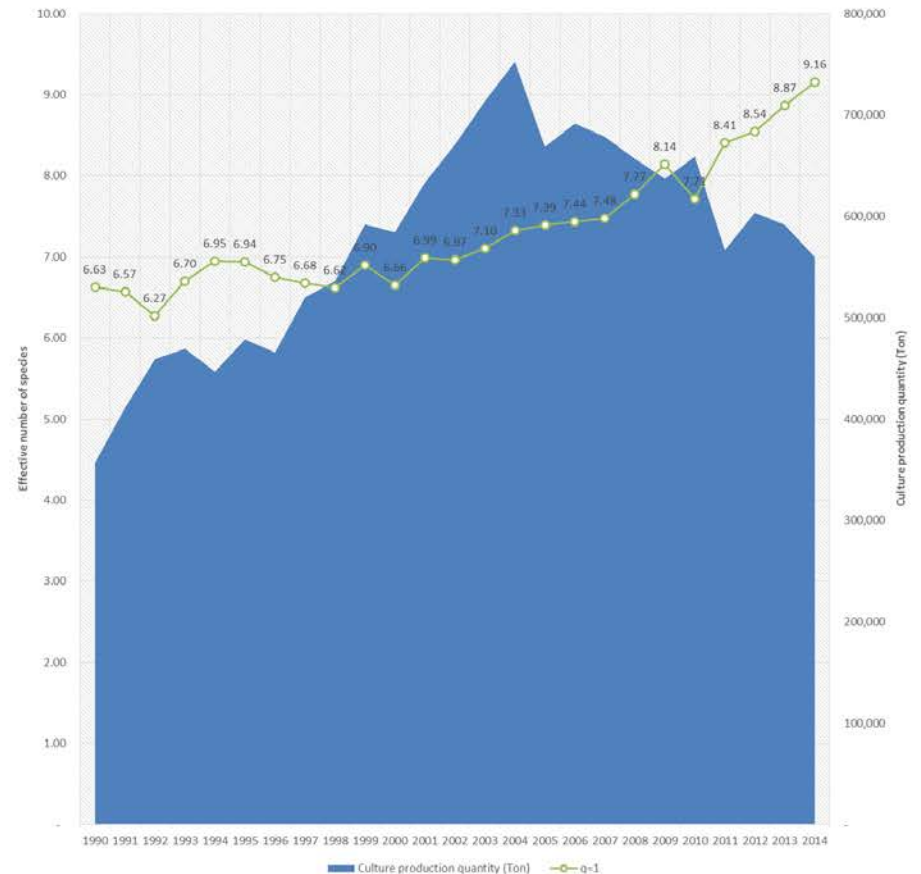


More species diversified aquaculture in Northern America

Aquaculture diversification during 1990-2014 (Country/area = Northern America; scope = Aquatic products; environment = All; area= all; measured by Culture production quantity)



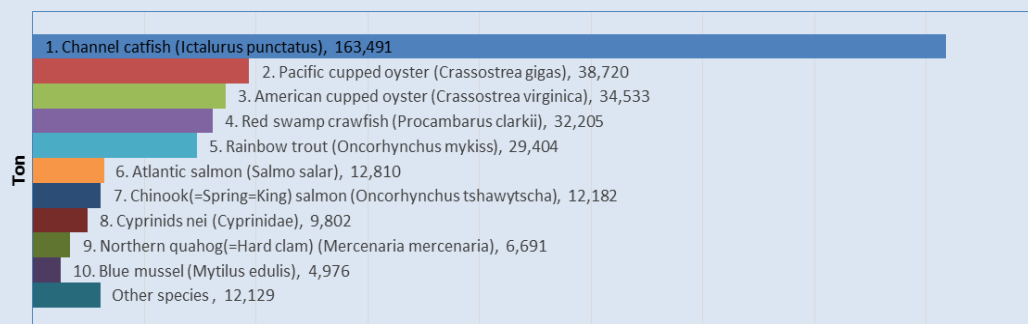
Aquaculture diversification during 1990-2014 (Country/area = Northern America; scope = Aquatic products; environment = All; area= all; measured by Culture production quantity)



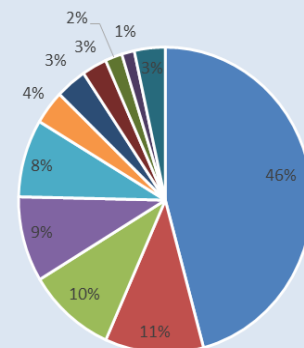
Top-10 species in Northern America: 1990 vs. 2014

Diversity in 1990 = 6.6

Northern America in 1990: Top-10 species groups under WAPI FishSTAT species grouping

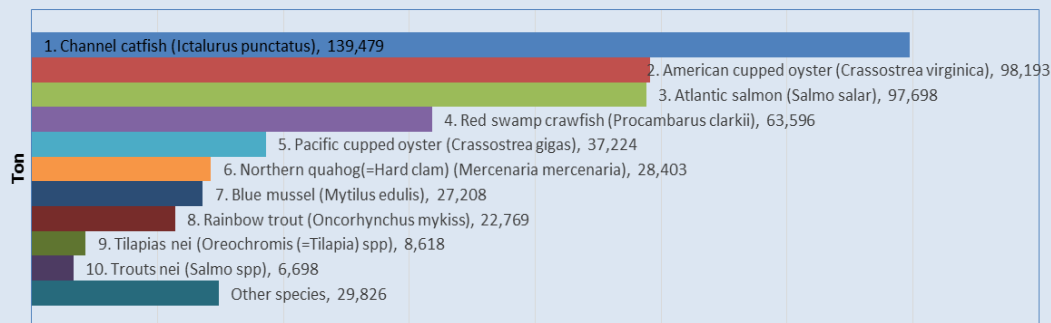


Share in total aquatic products (%)

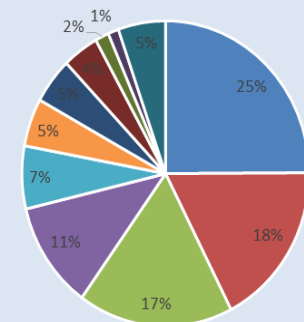


Diversity in 2014 = 9.2

Northern America in 2014: Top-10 species groups under WAPI FishSTAT species grouping

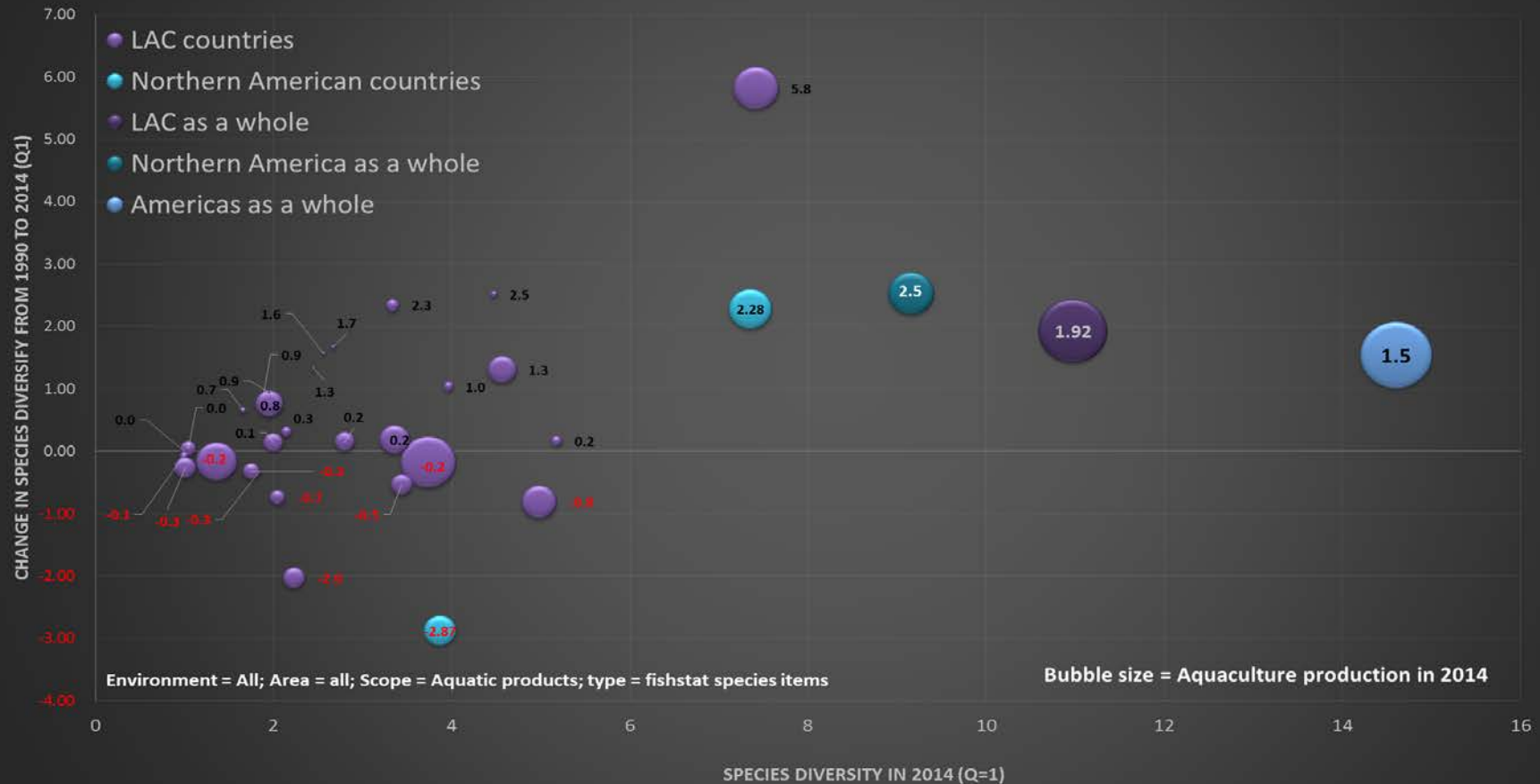


Share in total aquatic products (%)



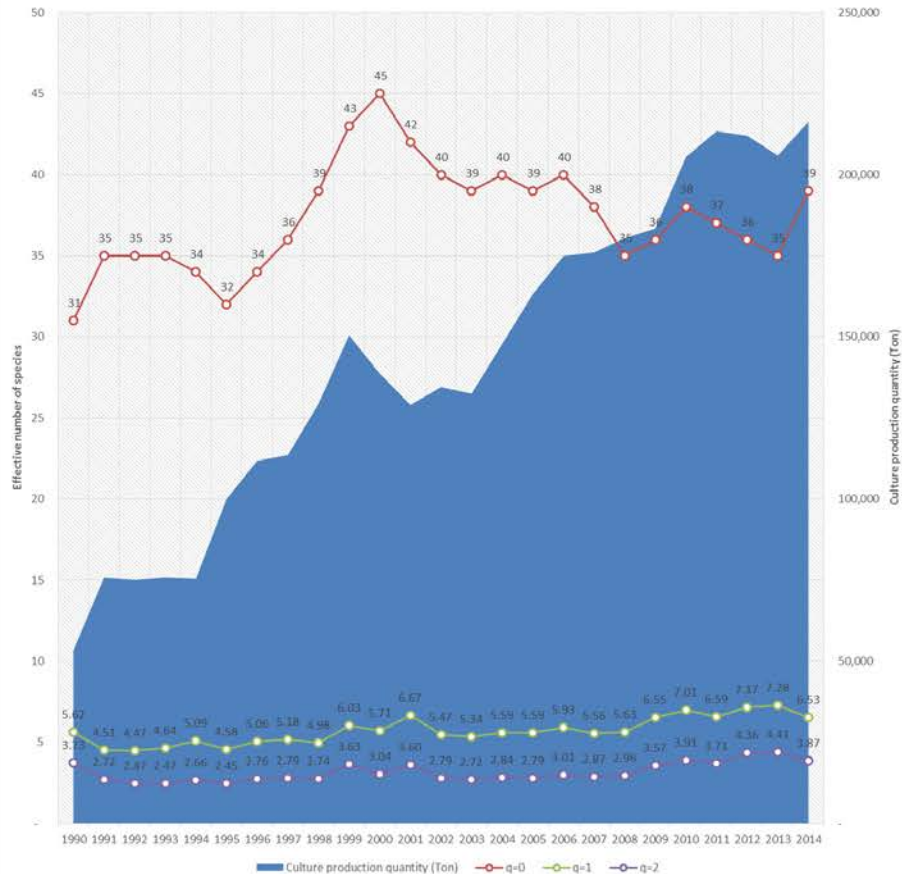
American countries

American countries

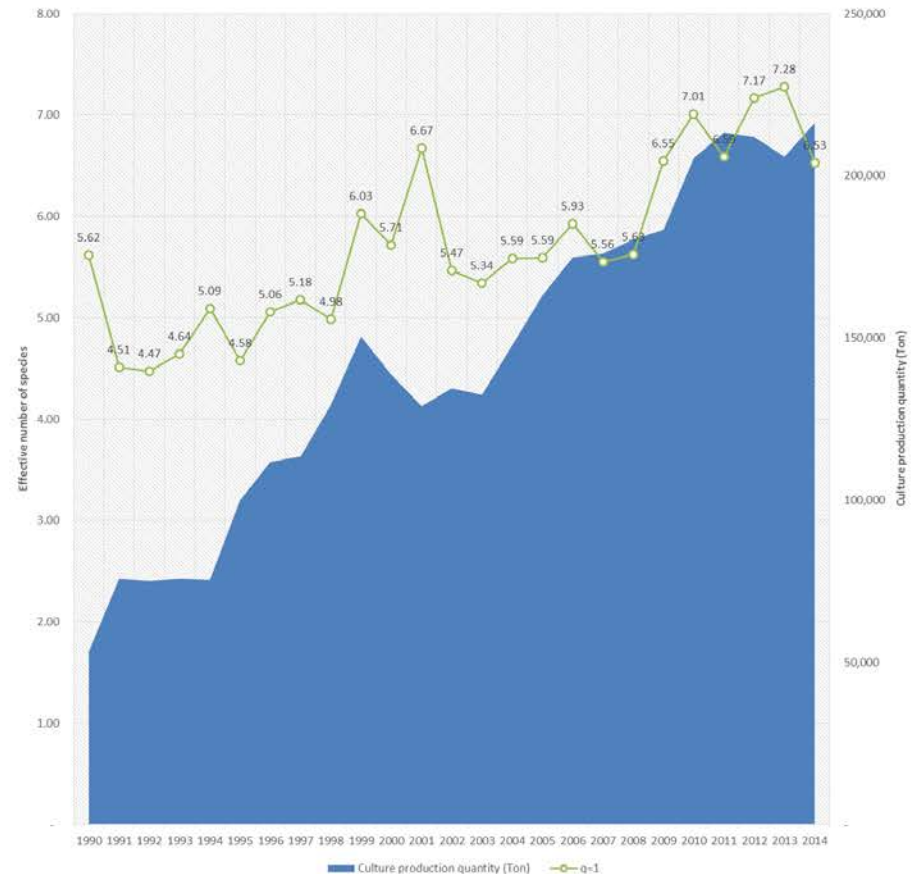


More species diversified aquaculture in Oceania

Aquaculture diversification during 1990-2014 (Country/area = Oceania;
scope = Aquatic products; environment = All; area= all; measured by
Culture production quantity)



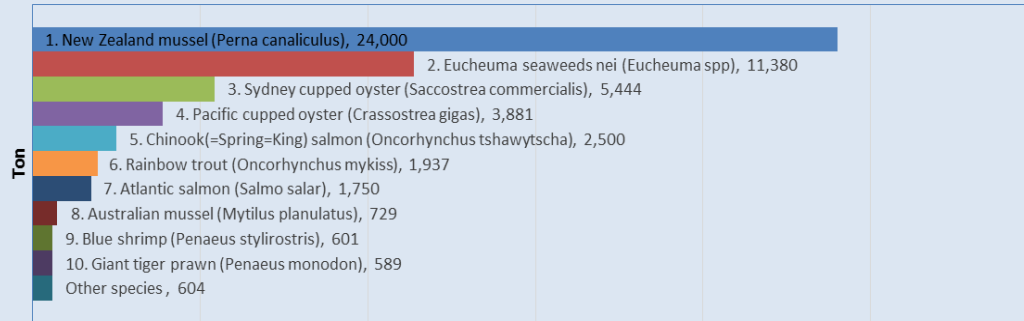
Aquaculture diversification during 1990-2014 (Country/area = Oceania;
scope = Aquatic products; environment = All; area= all; measured by
Culture production quantity)



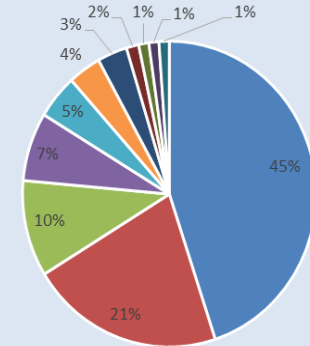
Top-10 species in Oceania: 1990 vs. 2014

Diversity in 1990 = 5.6

Oceania in 1990: Top-10 species groups under WAPI FishSTAT species grouping

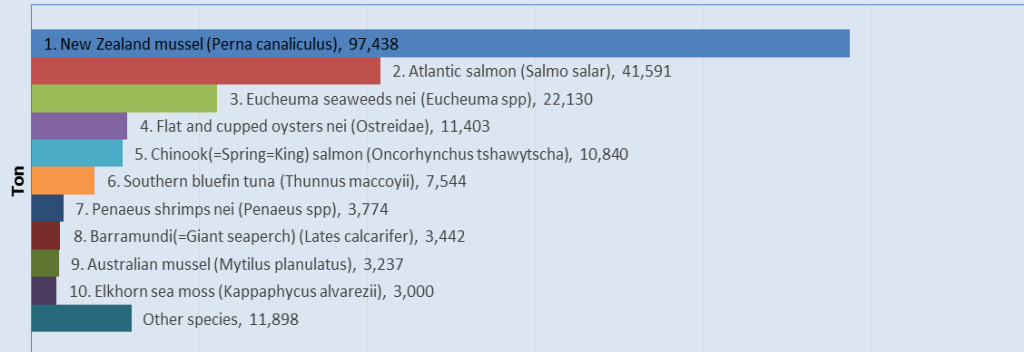


Share in total aquatic products (%)

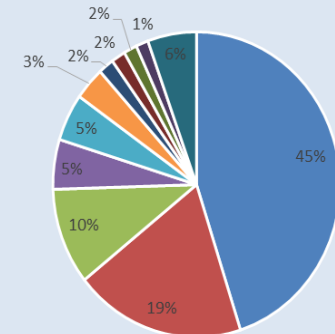


Diversity in 2014 = 6.5

Oceania in 2014: Top-10 species groups under WAPI FishSTAT species grouping

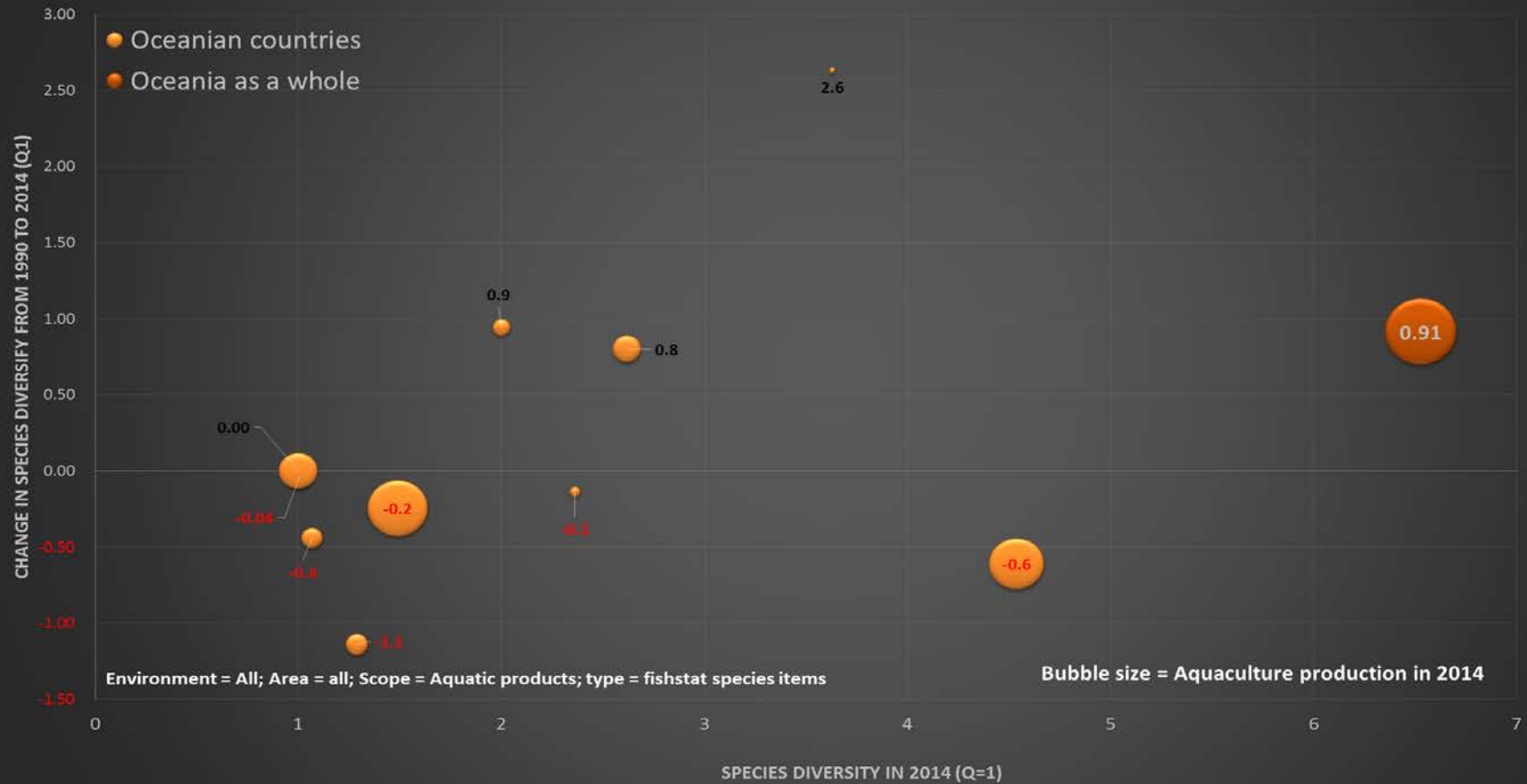


Share in total aquatic products (%)



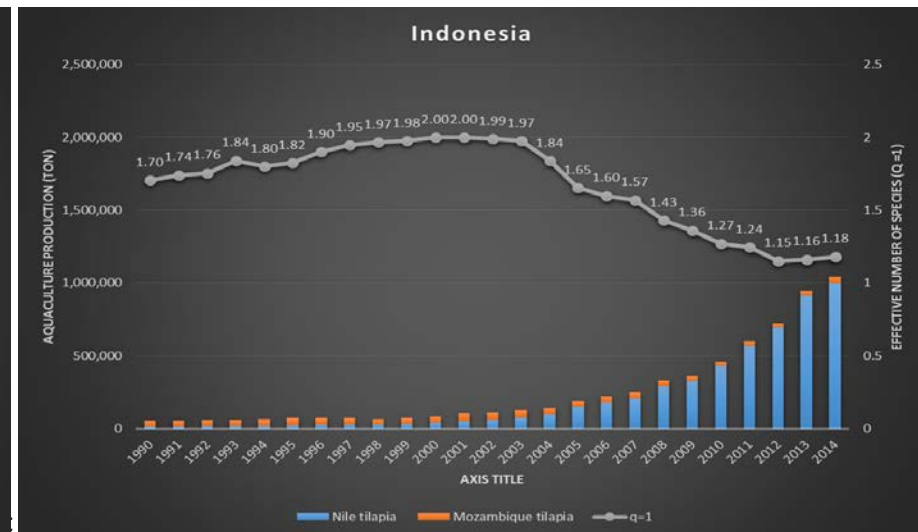
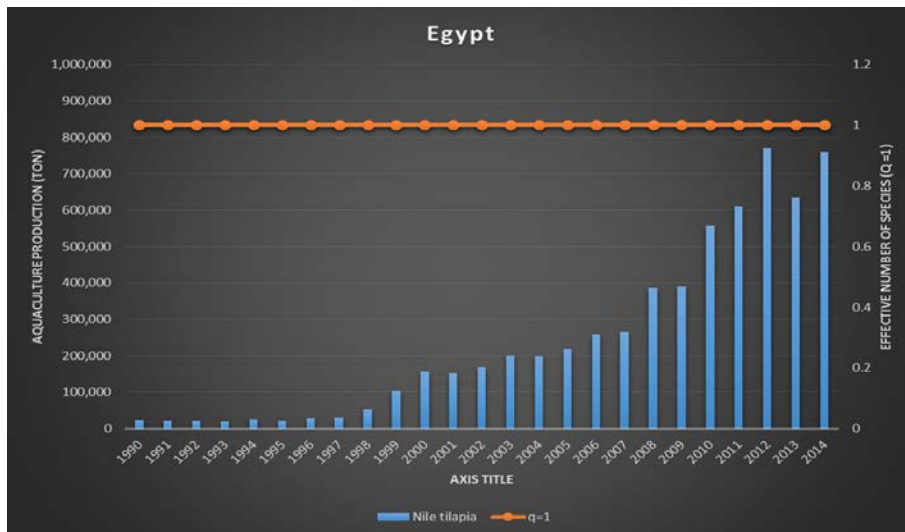
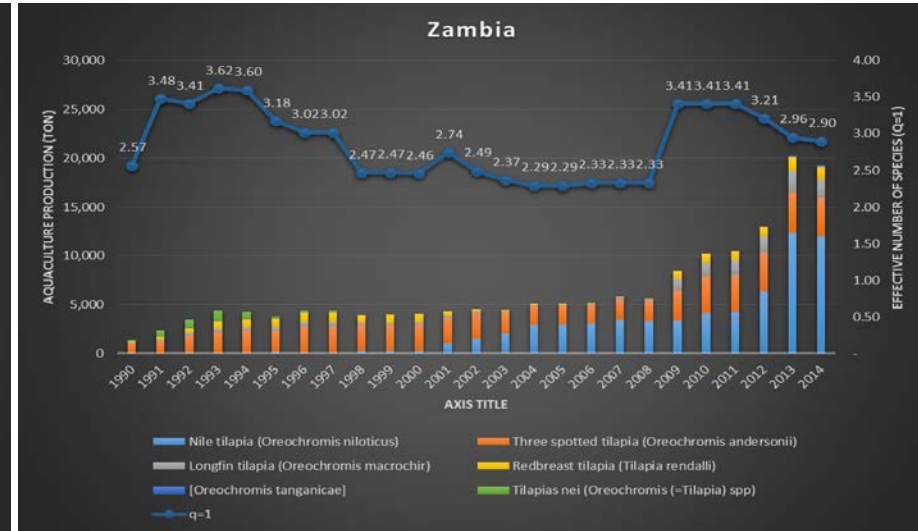
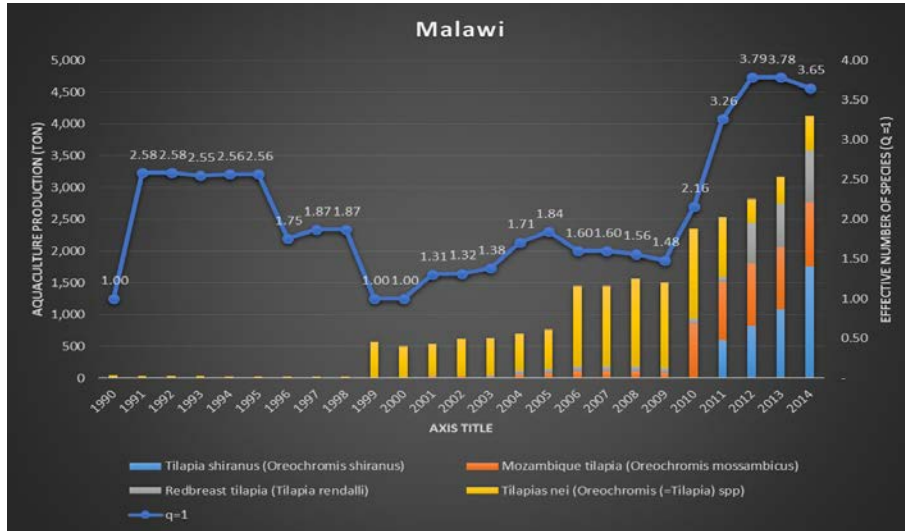
Oceanian countries

Oceania

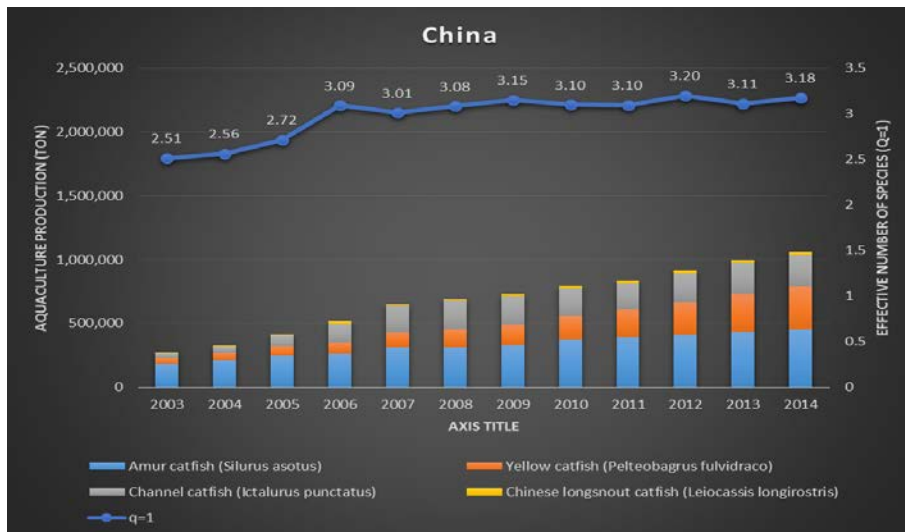
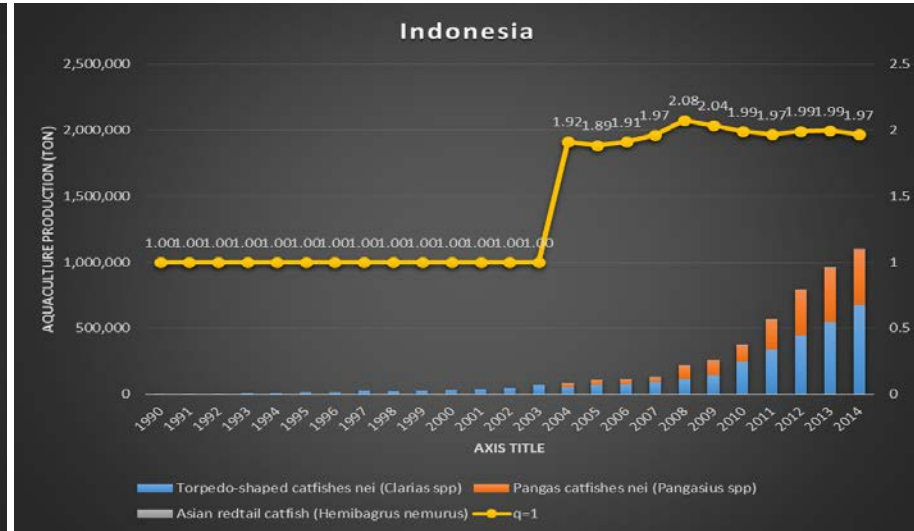
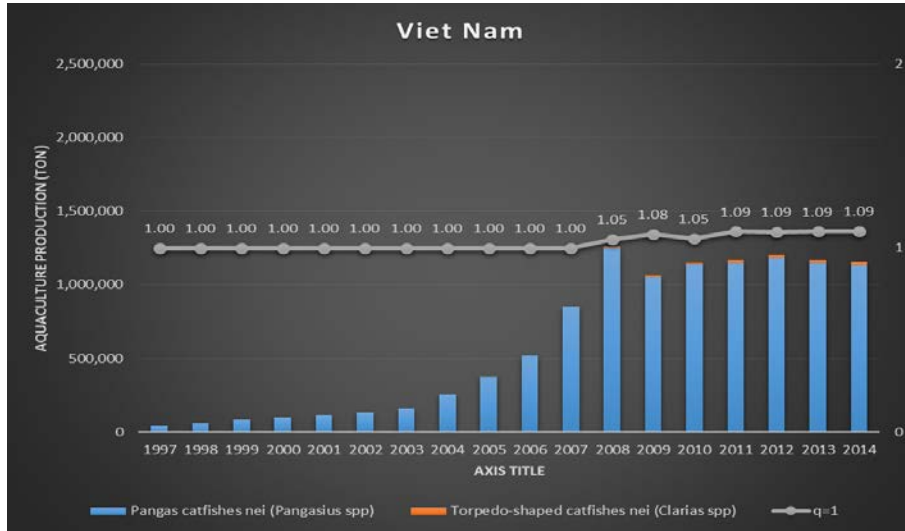


Species diversification for
different species scopes

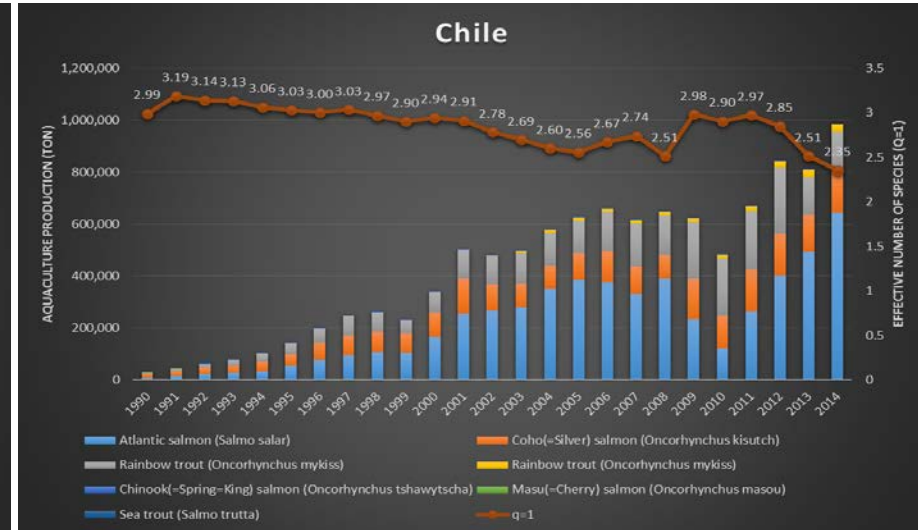
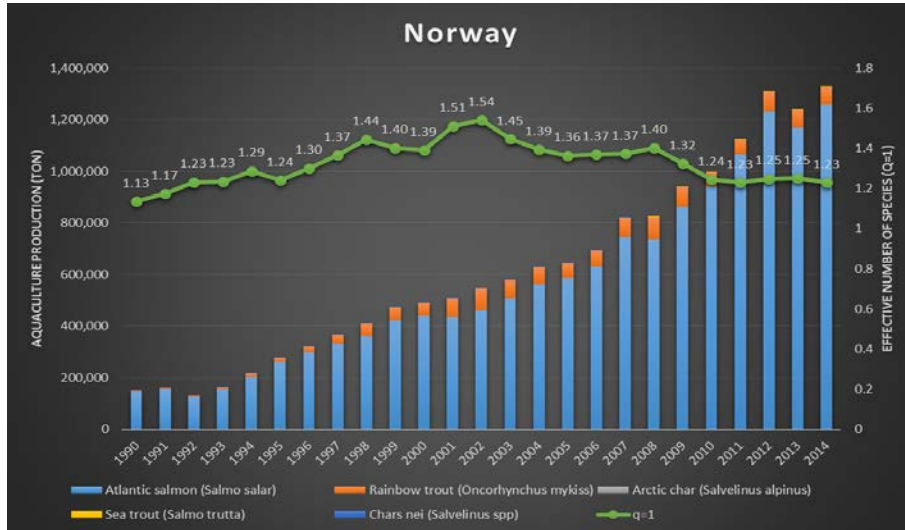
Species diversification in tilapia farming



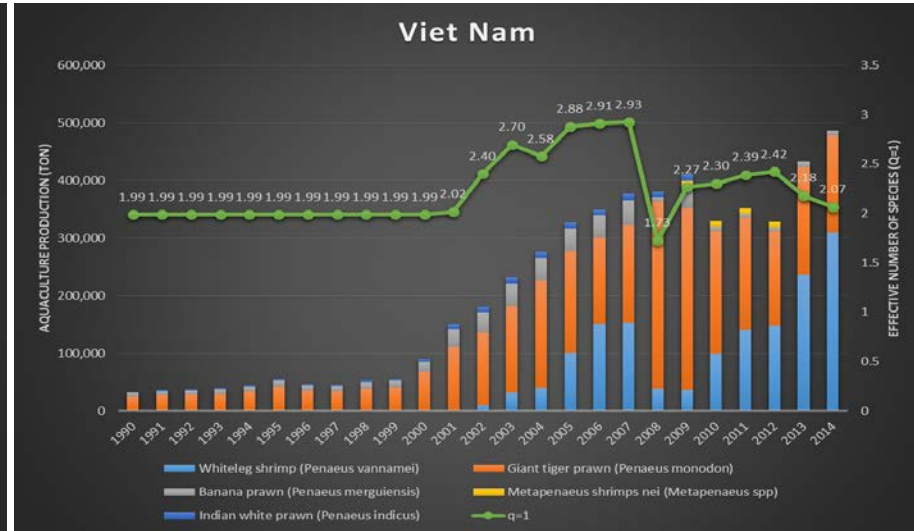
Species diversification in catfish farming



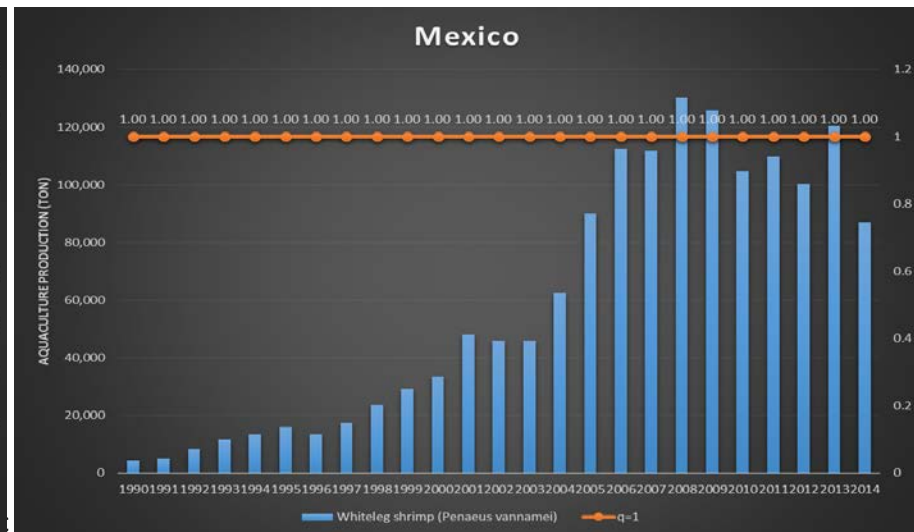
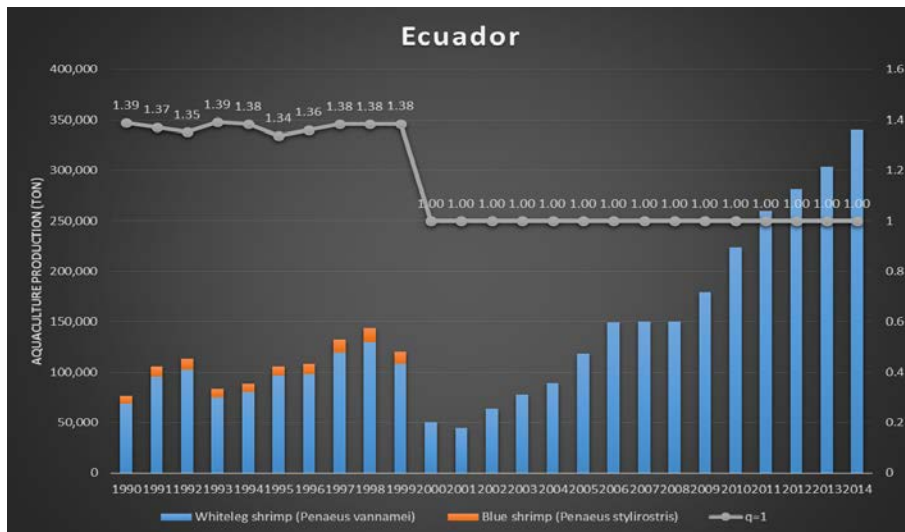
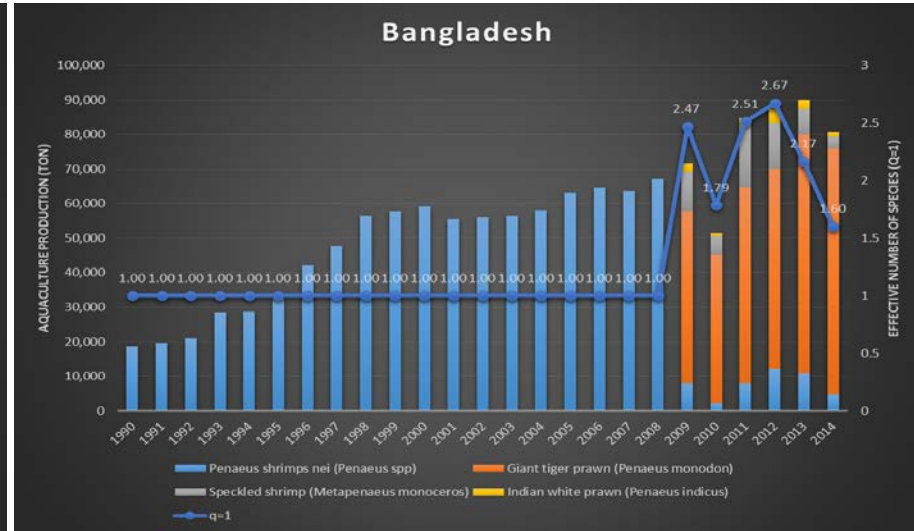
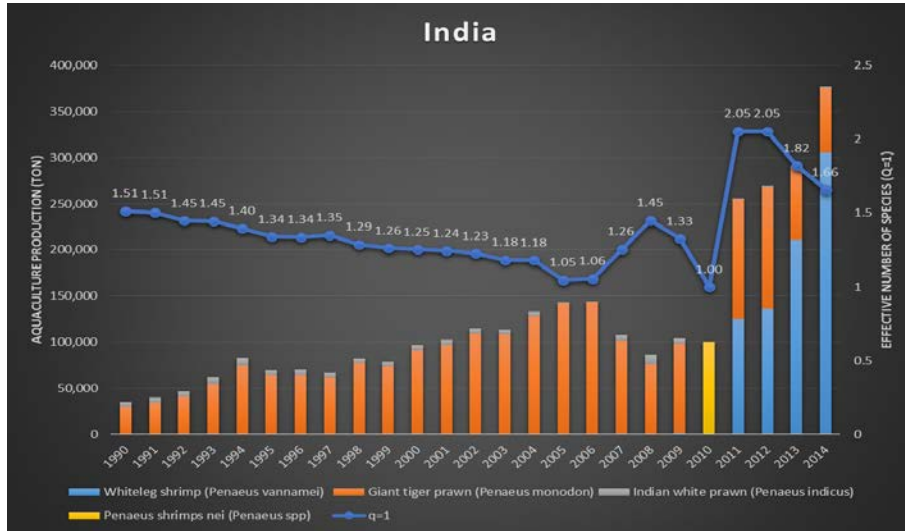
Species diversification in salmonid farming



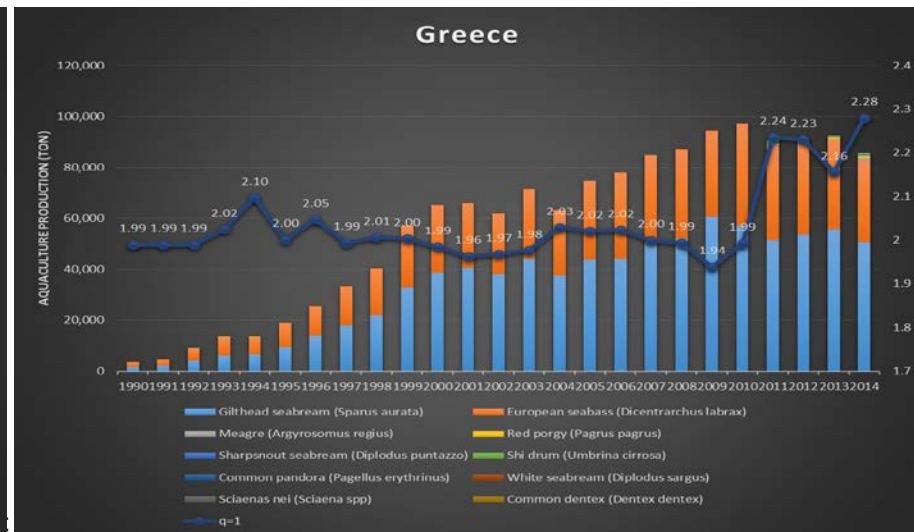
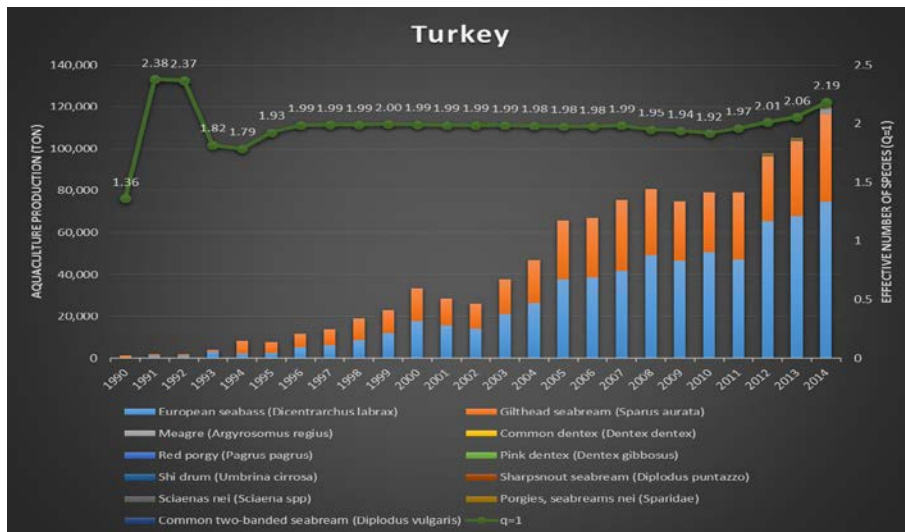
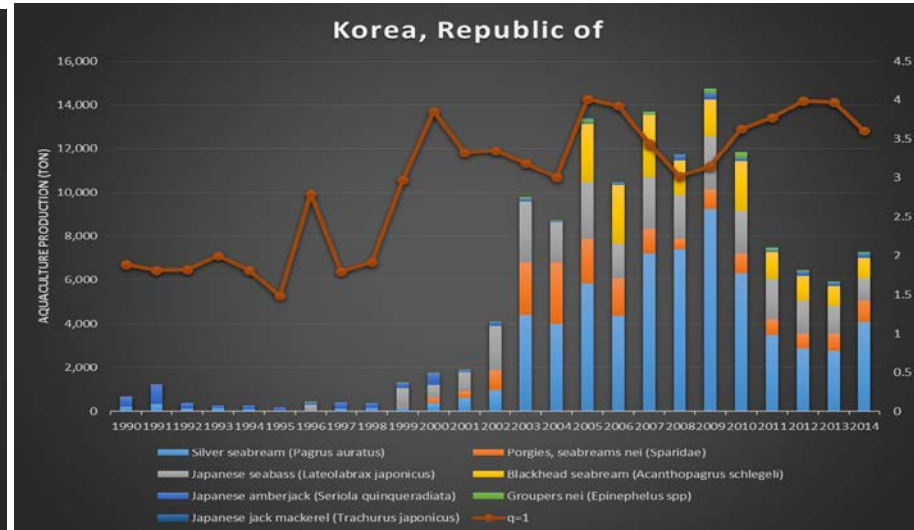
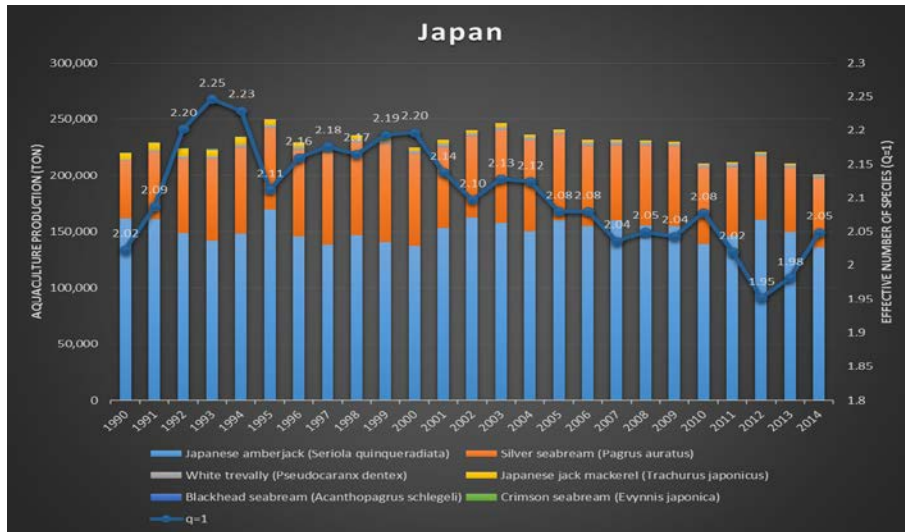
Species diversification in marine shrimps and prawns farming (I)



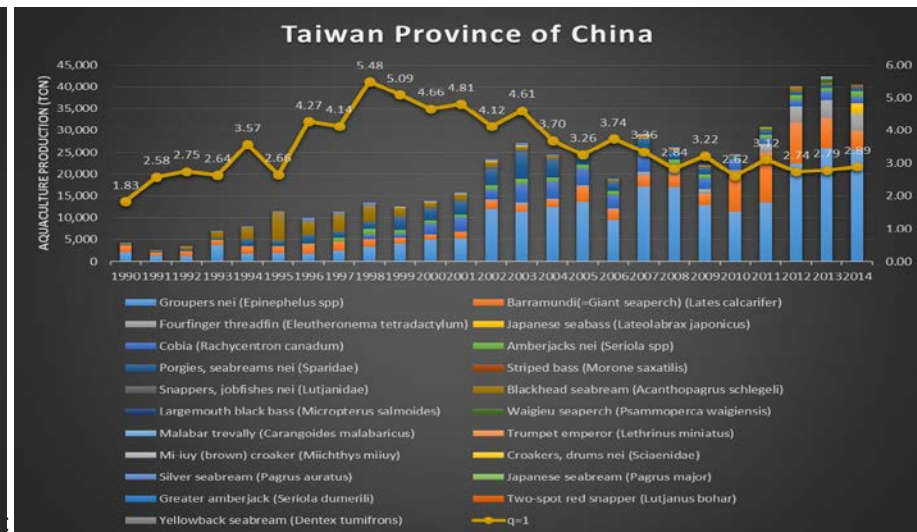
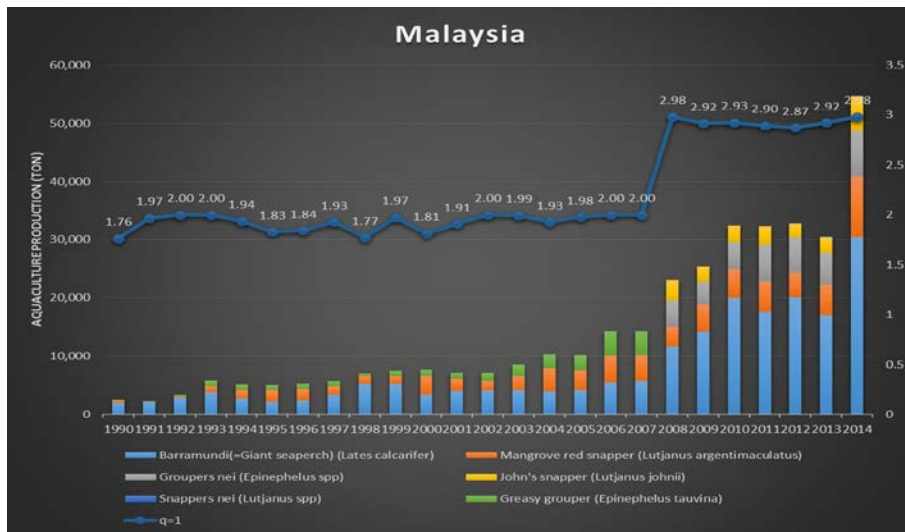
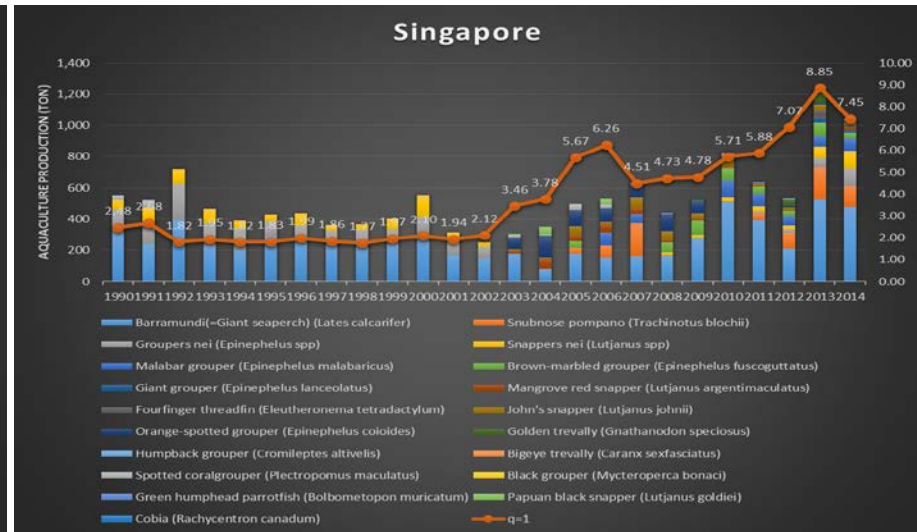
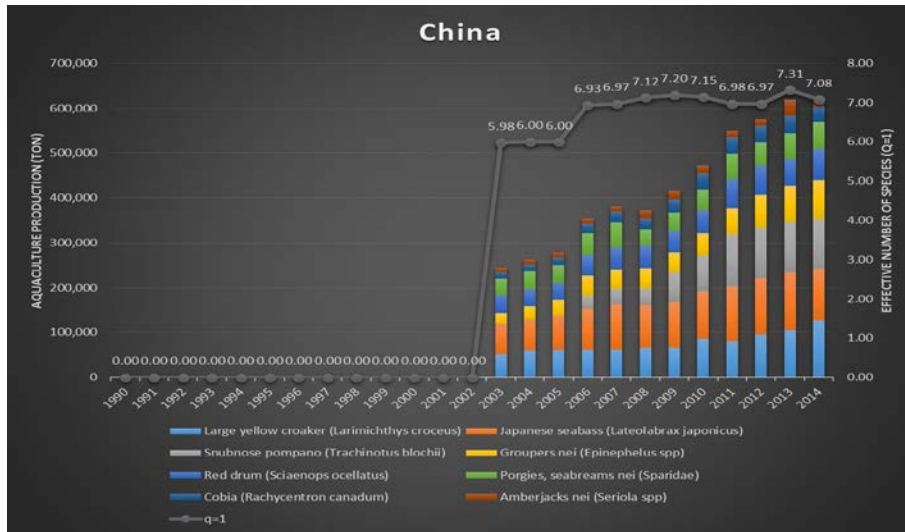
Species diversification in marine shrimps and prawns farming (II)



Species diversification in marine perch_like fishes farming (I)

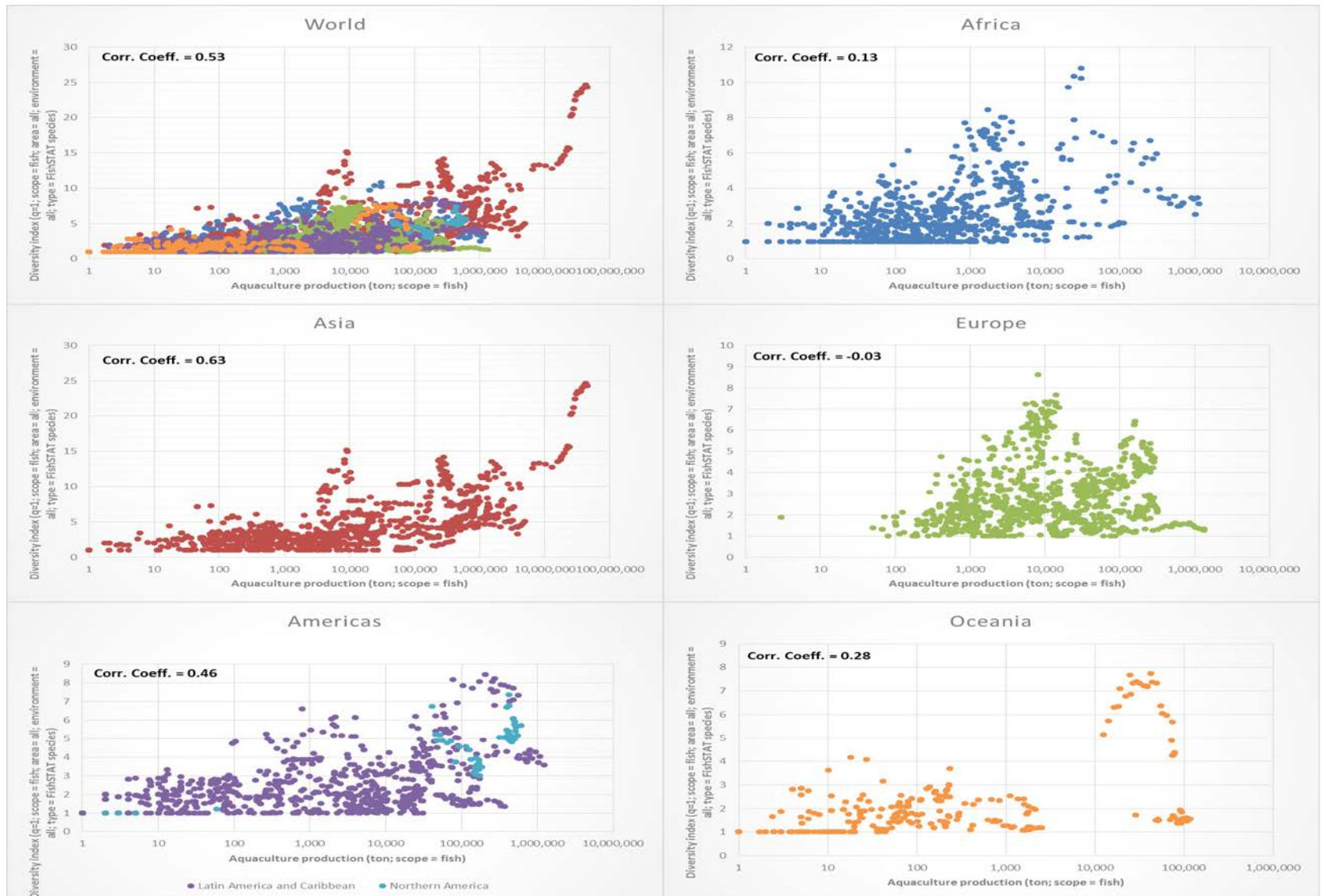


Species diversification in marine perch-like fishes farming (II)



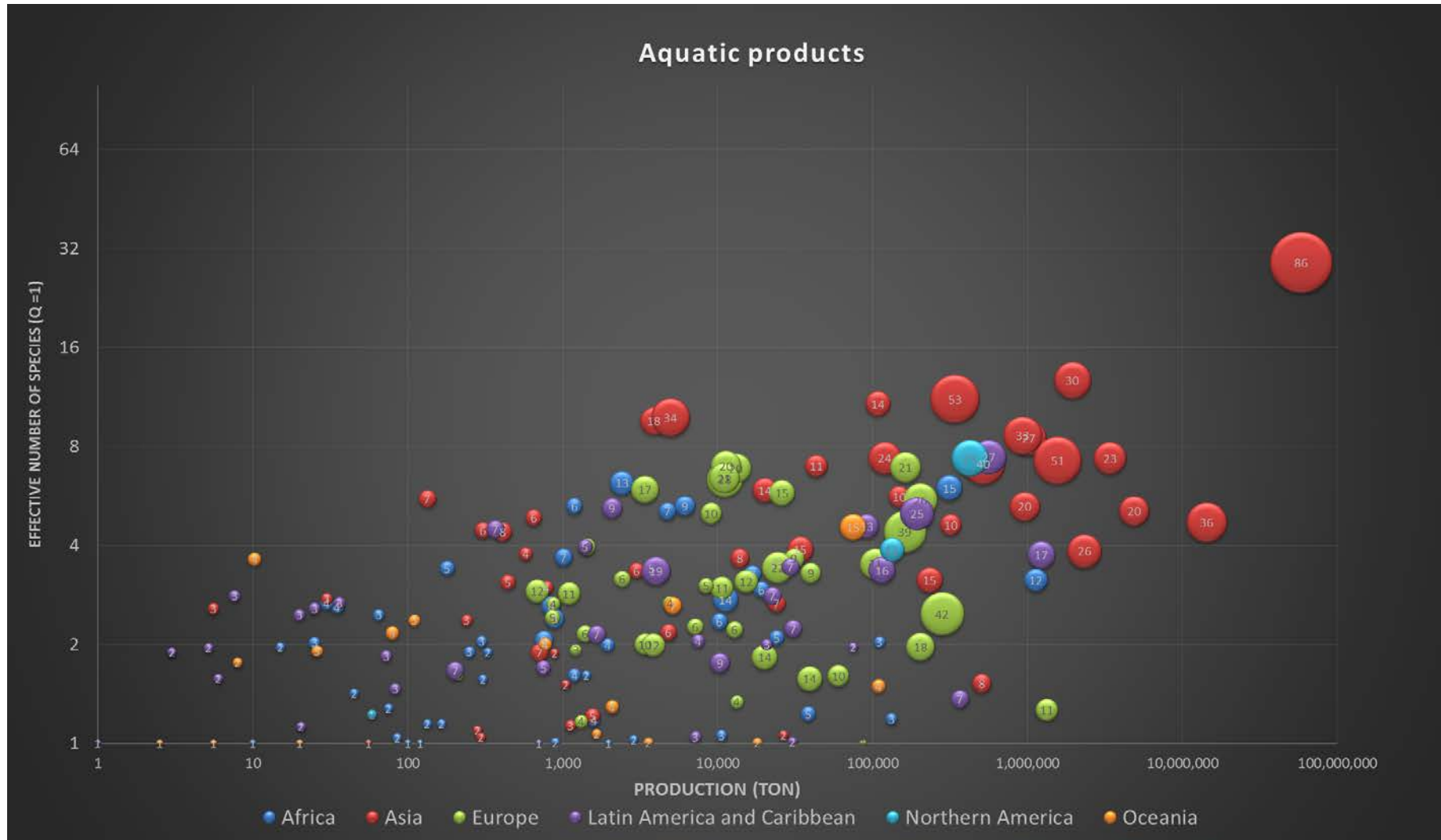
Salient patterns or stylized facts

Some evidence of positive correlation between farmed fish species diversification and production scale



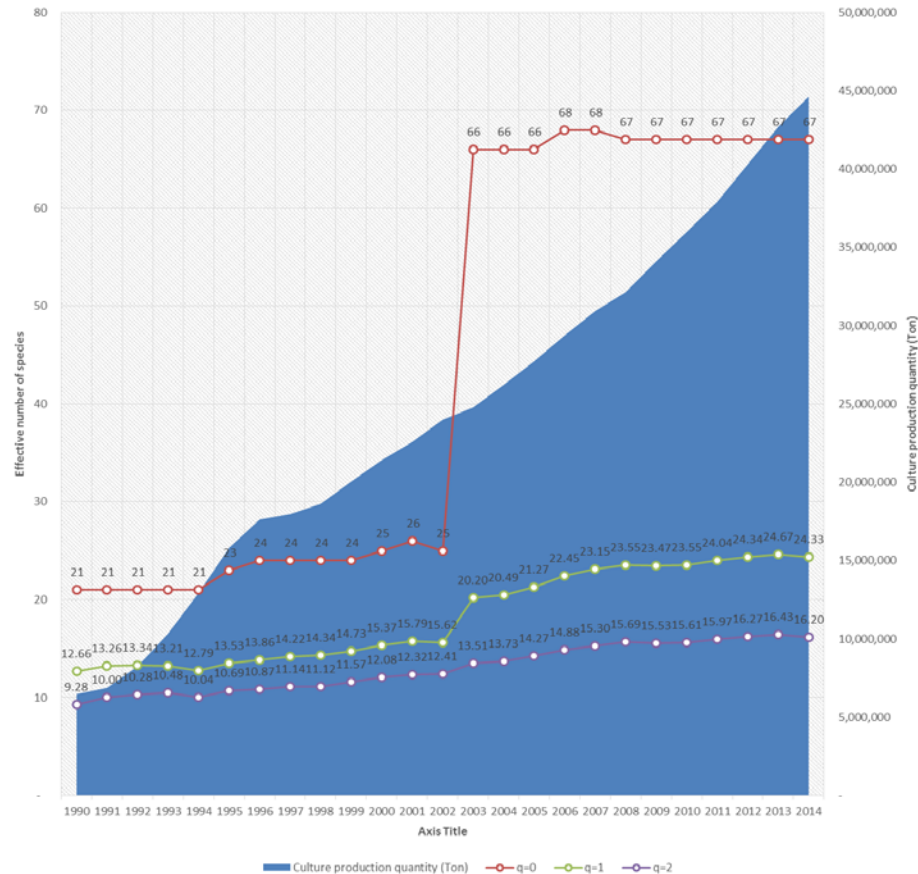
Year: 1990-2014; Area = All; Environment = All; Scope = Fish; Production measure = Quantity; Diversity measure (q = 1)

Aquaculture products: the larger the production; the greater the diversity

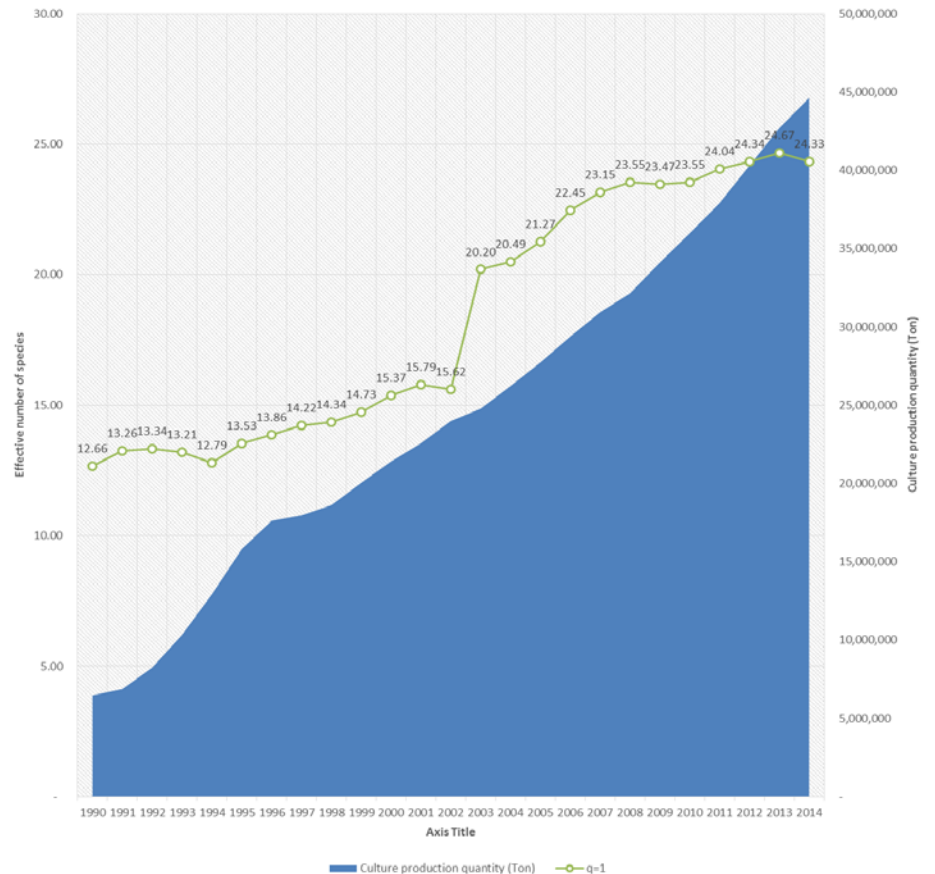


China: the largest and most diversified aquaculture producer

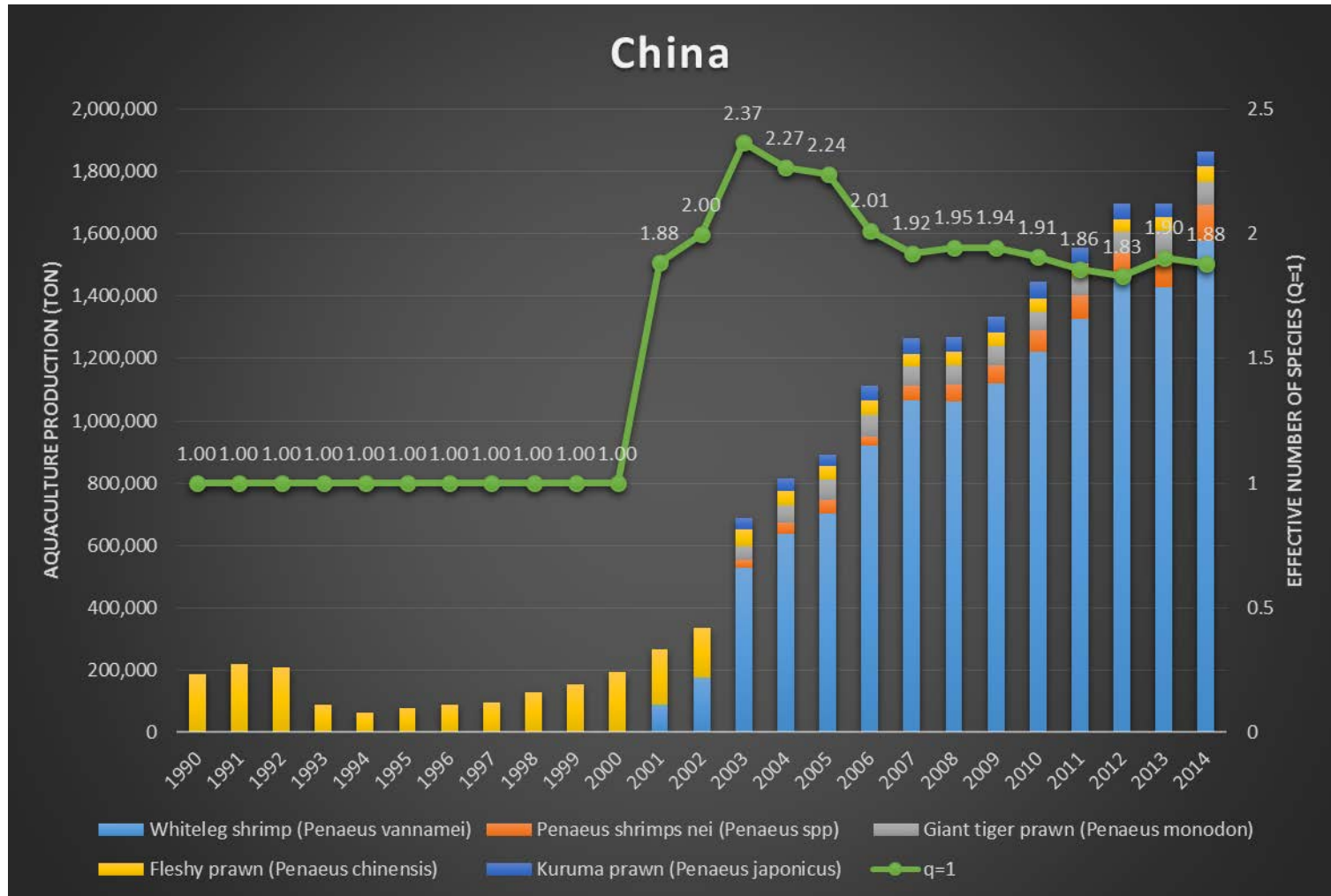
Aquaculture diversification during 1990-2014 (Country/area = china;
scope = Fish; environment = All; area= all; measured by Culture
production quantity)



Aquaculture diversification during 1990-2014 (Country/area = china;
scope = Fish; environment = All; area= all; measured by Culture
production quantity)



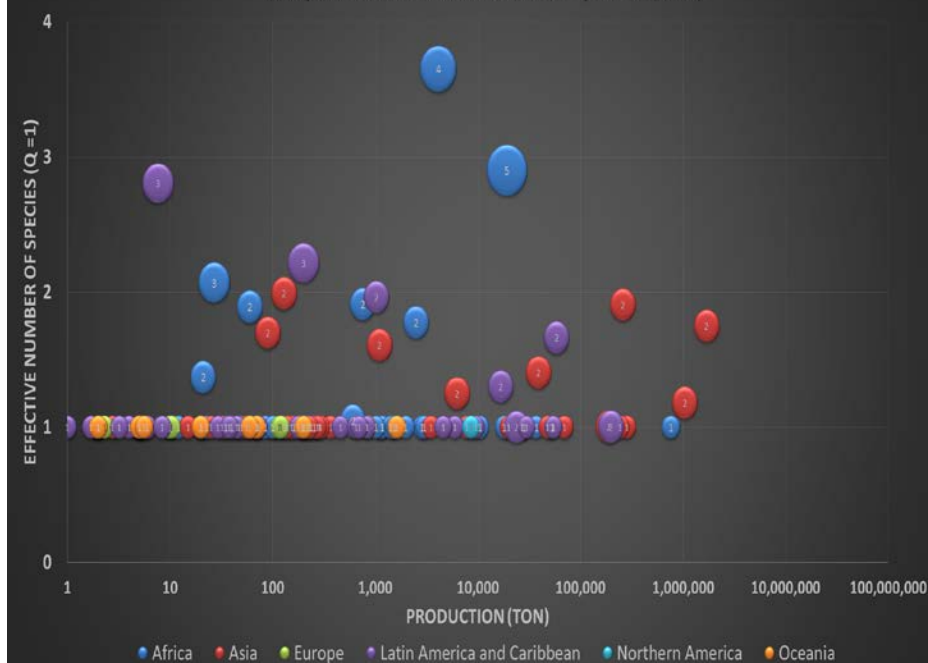
Declined species diversification in China's marine shrimps and prawn aquaculture



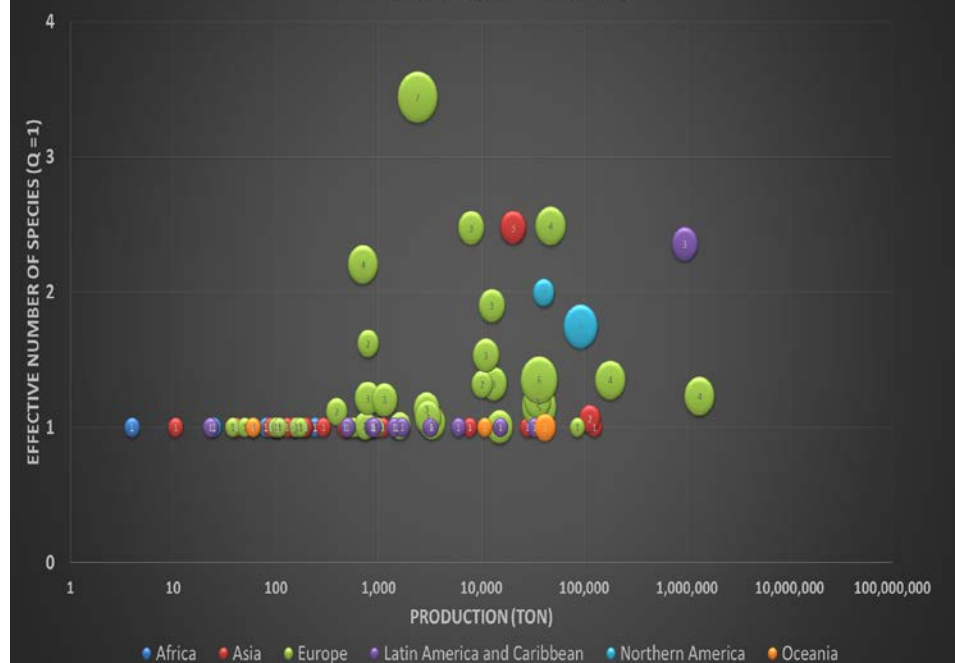
Year: 1990-2014; Area = All; Environment = All; Scope = Aquatic products; Diversity measure (q = 1)

Tilapias and Salmonids: the larger the production; the smaller the diversity

Tilapias and other cichlids (Cichlidae)

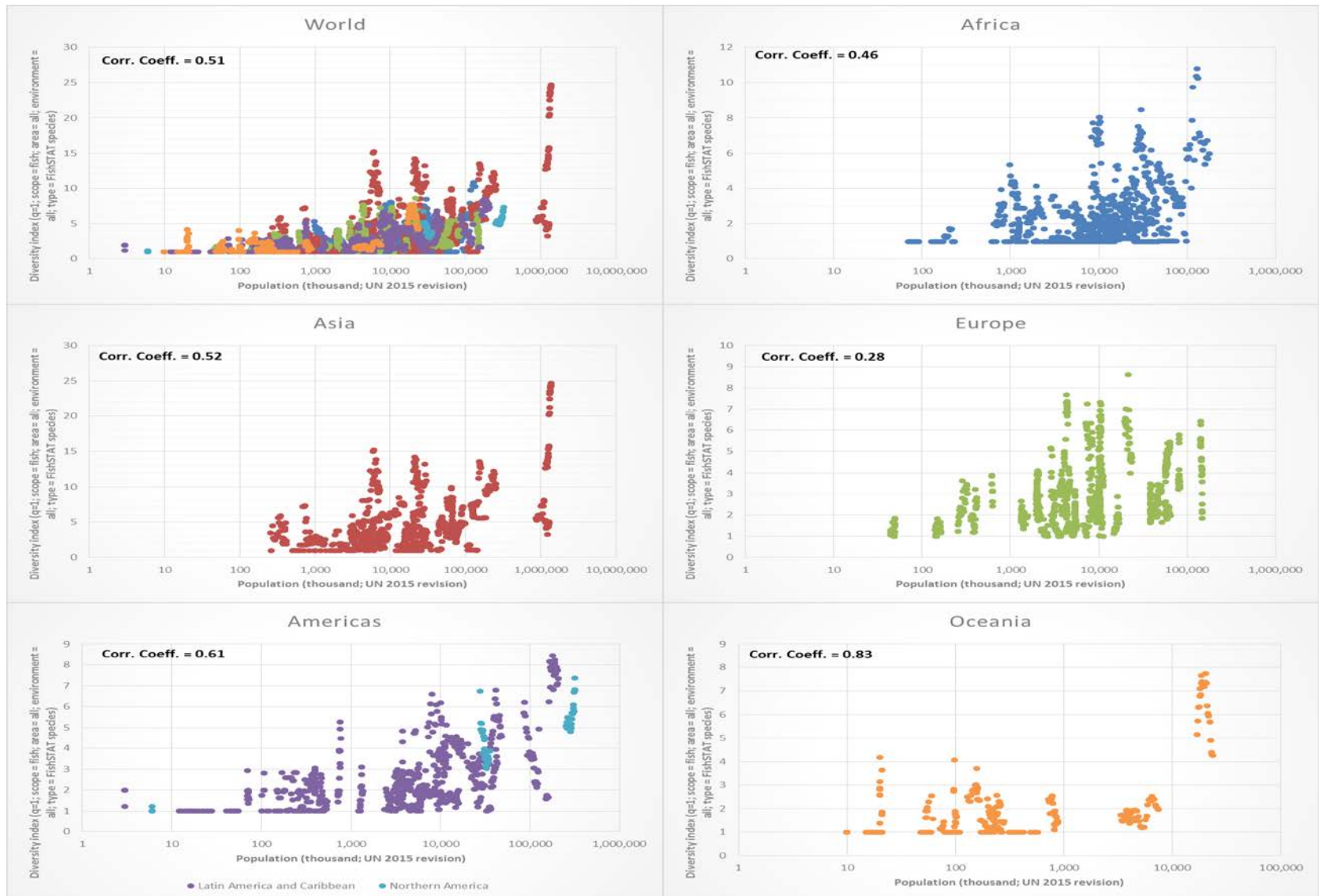


Salmonids (Salmonidae)



Year: 1990-2014; Area = All; Environment = All; Scope = Aquatic products; Diversity measure ($q=1$)

Some evidence of positive correlation between diversity and population



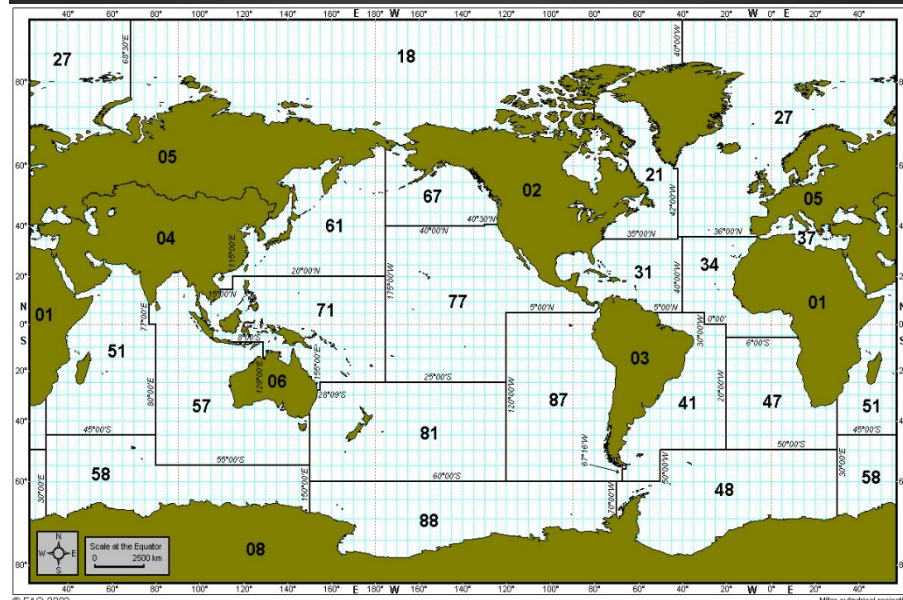
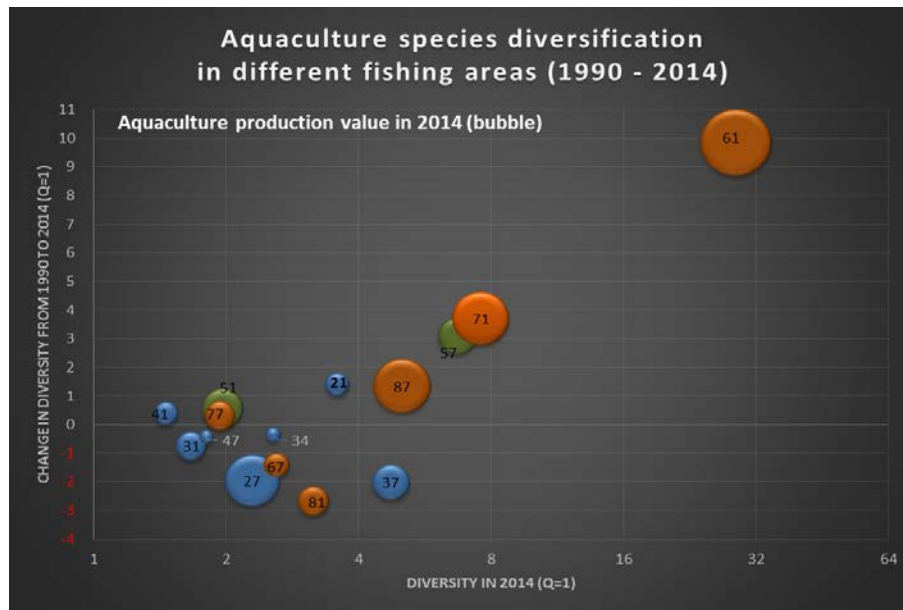
Year: 2000-2017; Area: All; Environment: All; Scope: Fish; Resolution: Medium; Quantity: Diversity; Measure: (q=1)

No obvious correlation between diversity and per capita income



Year: 2000; Area: All; Environment: All; Scope: Fish; Production Measure: Quantity; Diversity Measure: q=1

Aquaculture in Atlantic Ocean (coast) less diversified than Pacific or Indian Ocean (coast)



FAO Fishing Areas

Atlantic, Northwest (21)

Atlantic, Northeast (27)

Atlantic, Western Central (31)

Atlantic, Eastern Central (34)

Mediterranean and Black Sea (37)

Atlantic, Southwest (41)

Atlantic, Southeast (47)

Indian Ocean, Western (51)

Indian Ocean, Eastern (57)

Pacific, Northwest (61)

Pacific, Northeast (67)

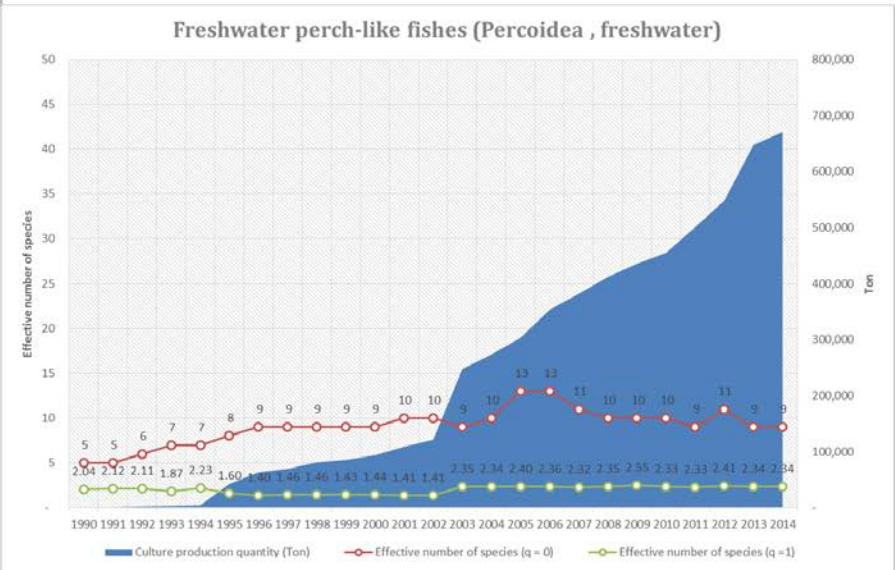
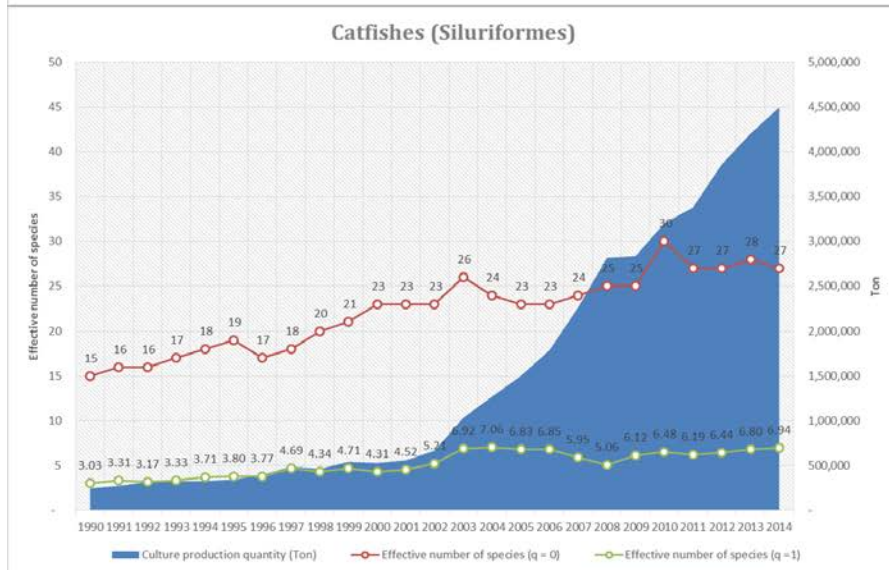
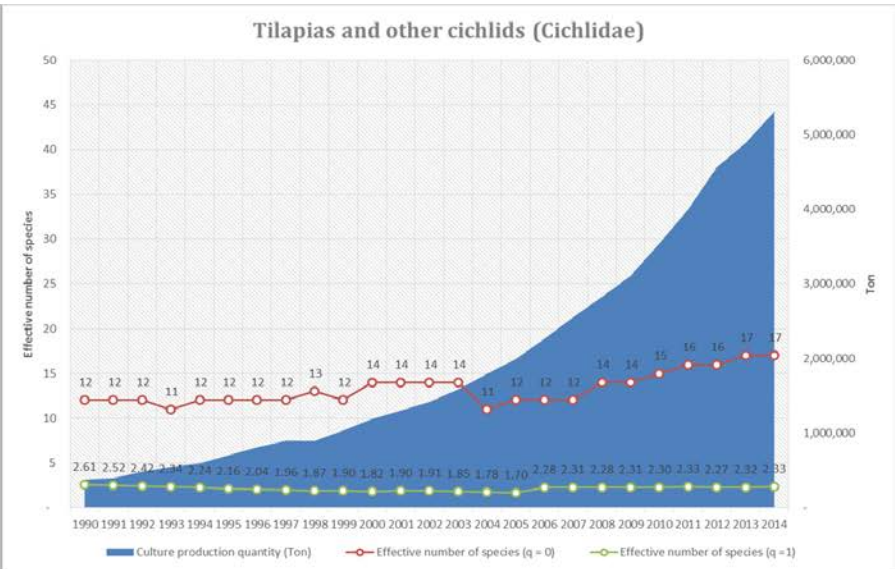
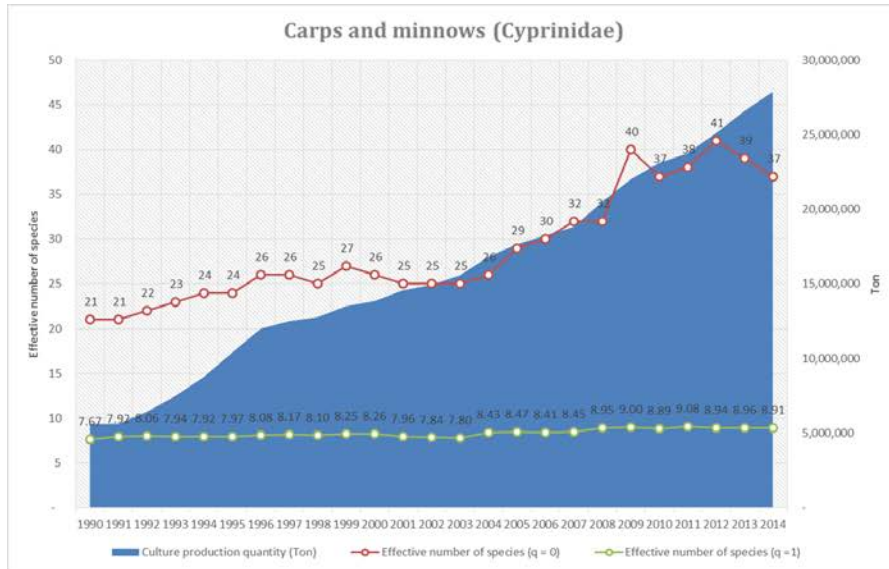
Pacific, Western Central (71)

Pacific, Eastern Central (77)

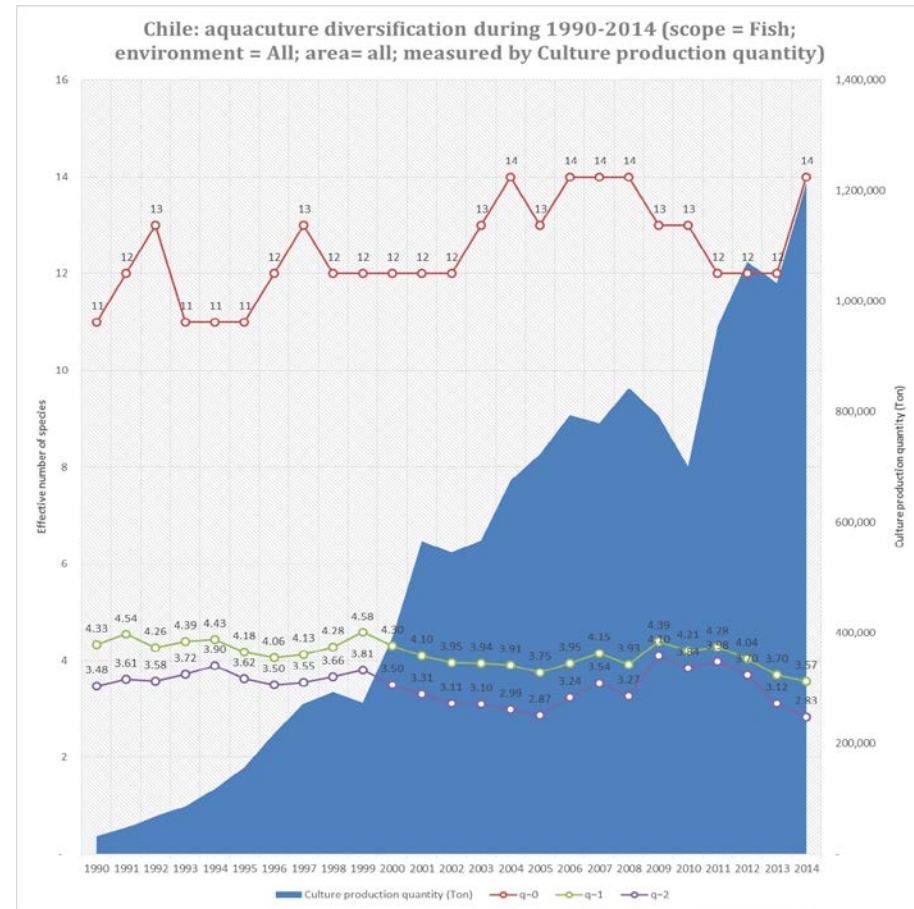
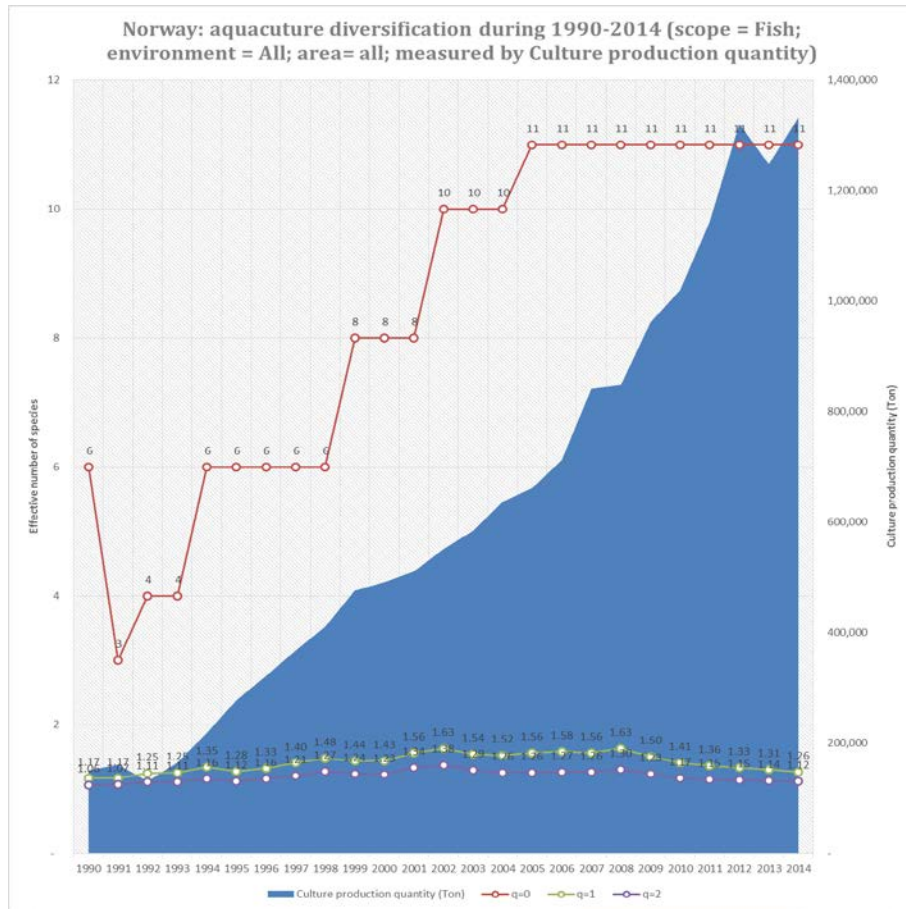
Pacific, Southwest (81)

Pacific, Southeast (87)

Tilapias: export oriented commodities tend to have less species diversity

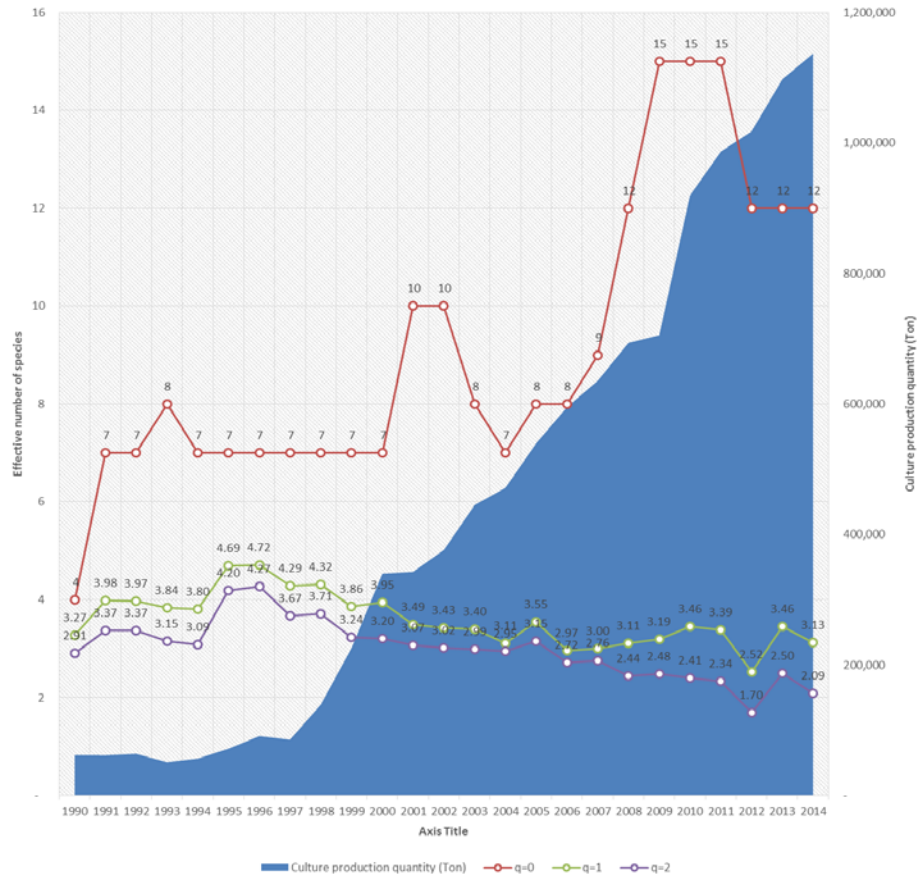


Norway and Chile: Export-oriented countries may have large production yet low diversity

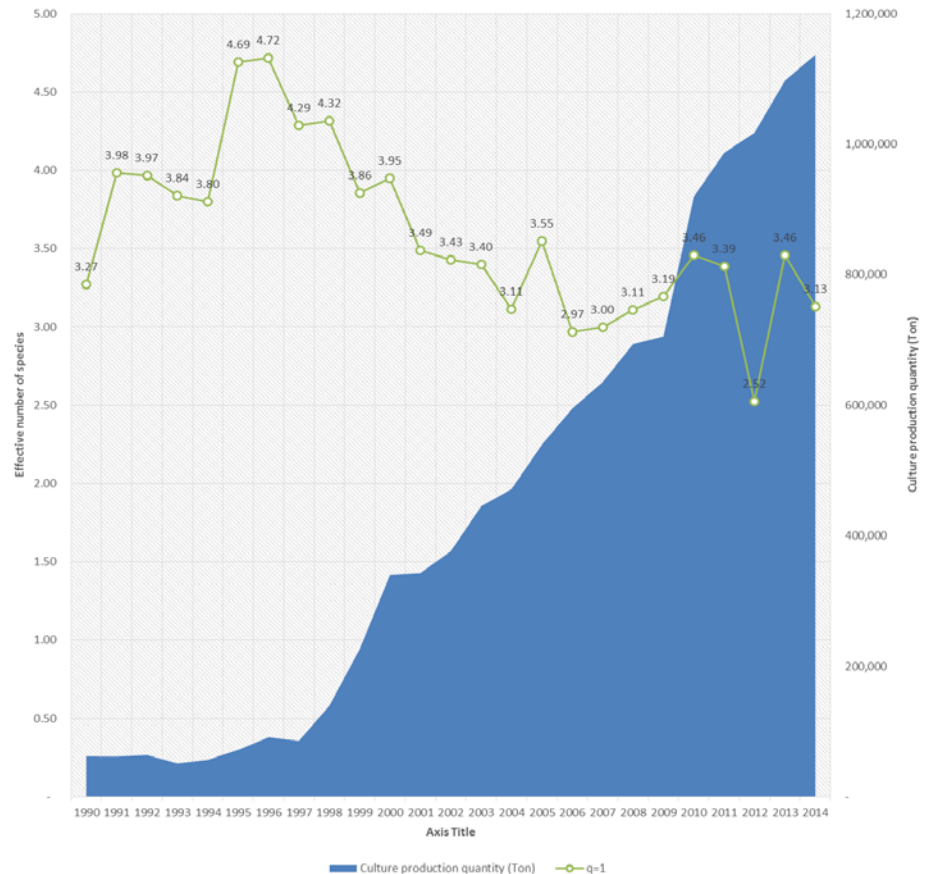


Egypt: country with less diverse aquaculture resources may have large production yet low diversity

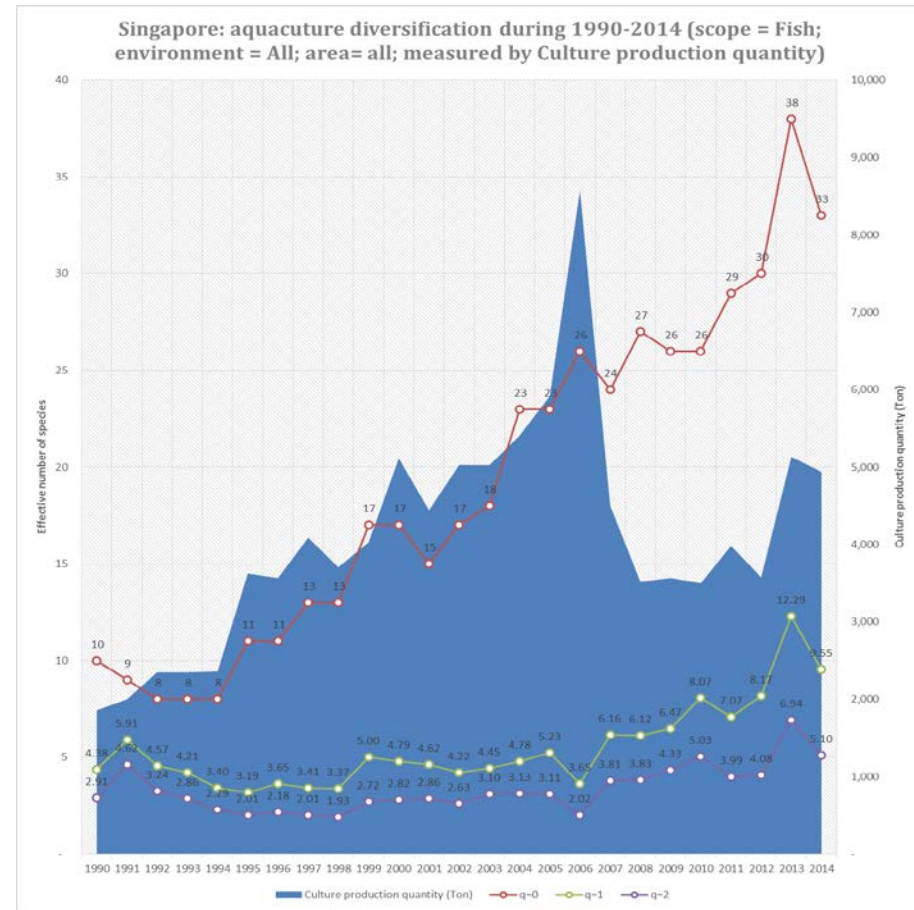
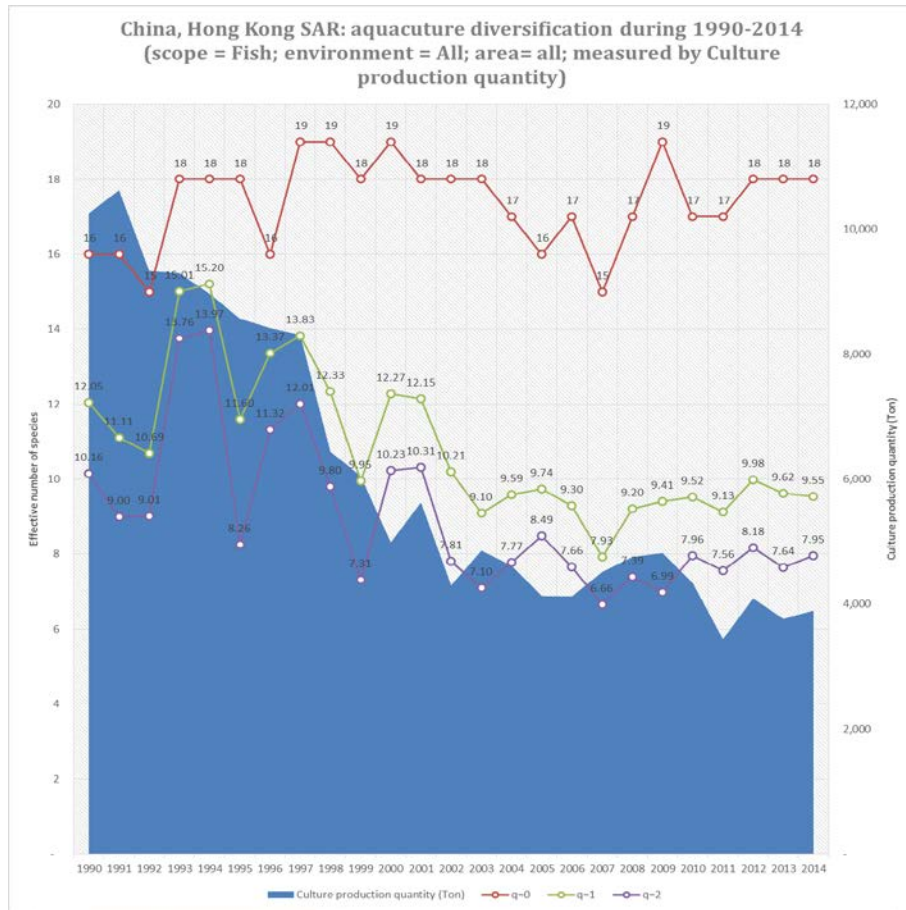
Aquaculture diversification during 1990-2014 (Country/area = Egypt; scope = fish; environment = All; area= all; measured by Culture production quantity)



Aquaculture diversification during 1990-2014 (Country/area = Egypt; scope = fish; environment = All; area= all; measured by Culture production quantity)

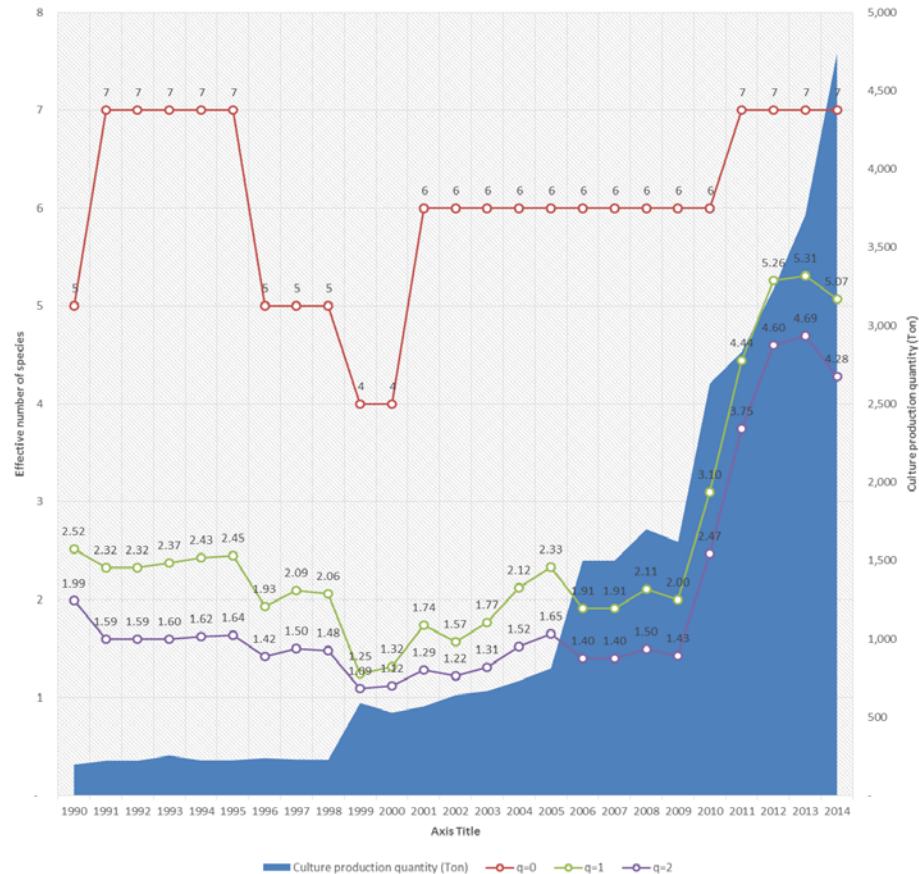


Hong Kong and Singapore: High income cities with strong preference over seafood may have small production yet high diversity

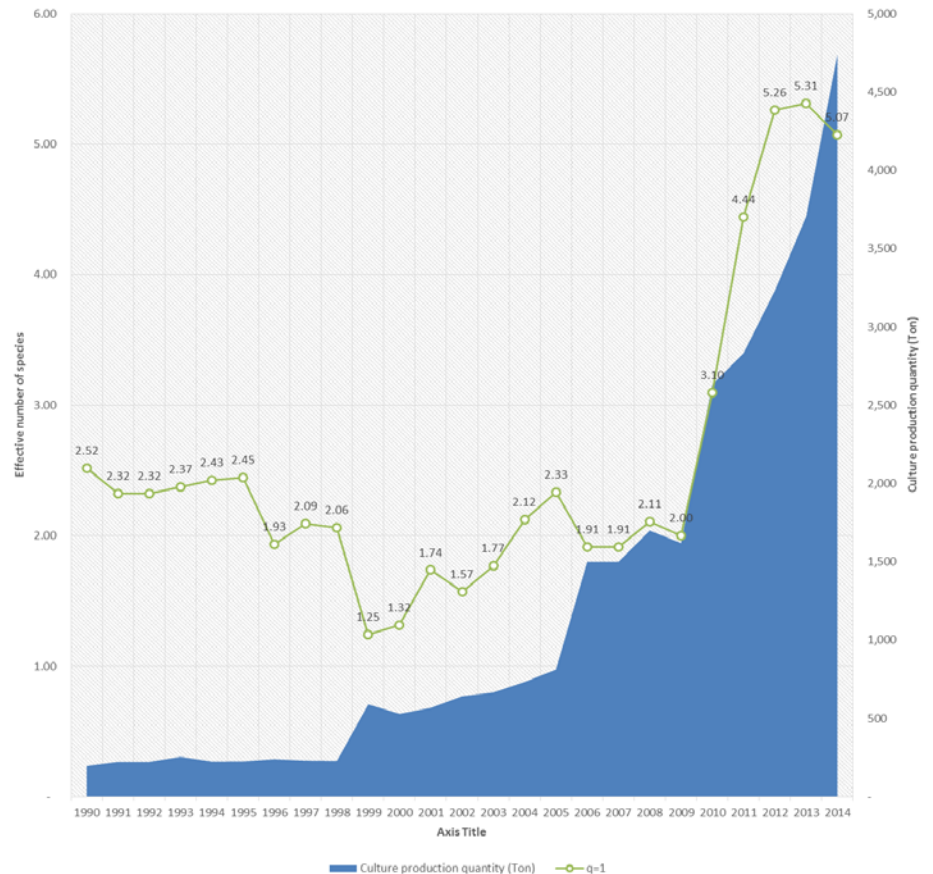


Malawi: high diversity because of restriction over introduced species

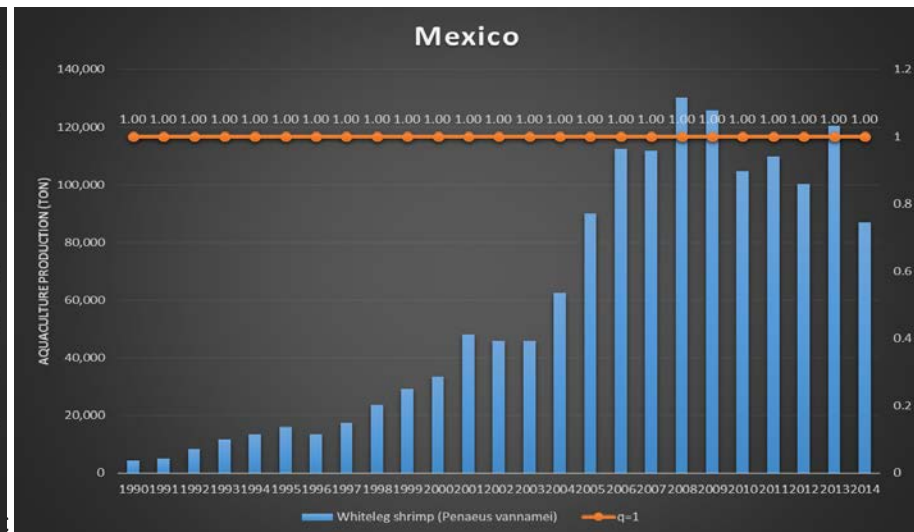
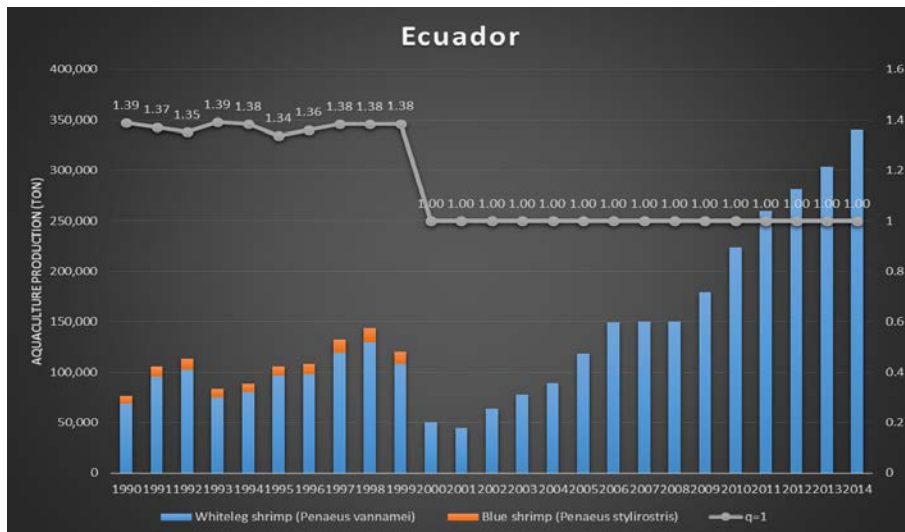
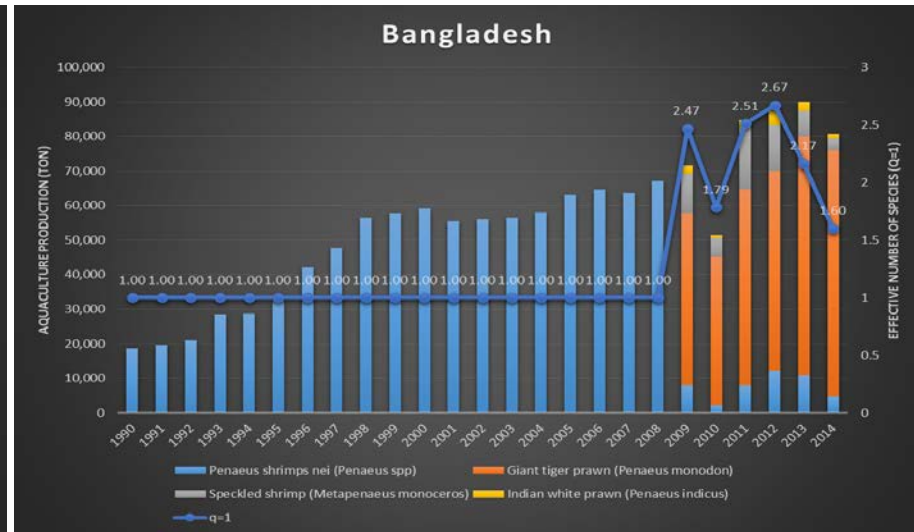
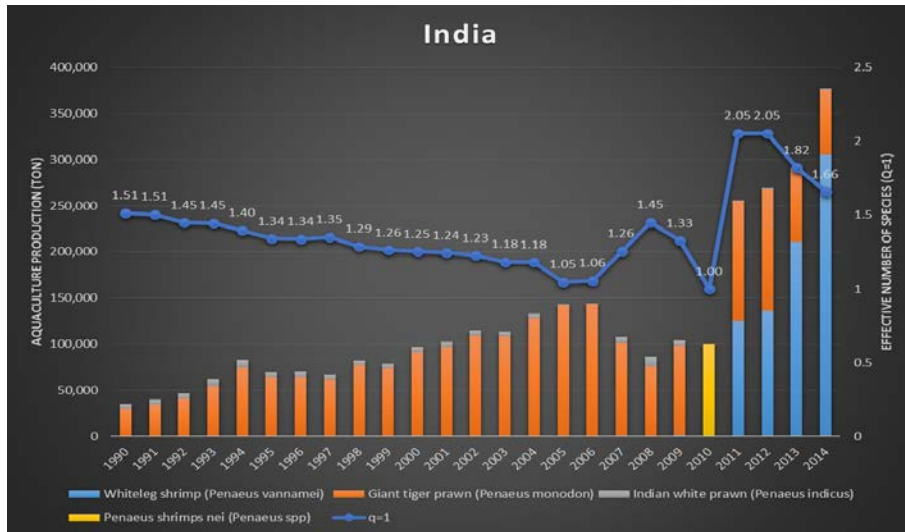
Aquaculture diversification during 1990-2014 (Country/area = Malawi; scope = fish; environment = All; area= all; measured by Culture production quantity)



Aquaculture diversification during 1990-2014 (Country/area = Malawi; scope = fish; environment = All; area= all; measured by Culture production quantity)



Marine shrimps and prawns: large-scale producers tend to be less species diversified than small-holder producers



Part III: Use of knowledge and information about species diversification patterns for evidence-based decision making

Lessons learned

- Species diversification patterns are under the influence of many factors.
- Different countries tend to have different species diversification patterns.
- A country tends to have different species diversification patterns at different aquaculture development stages.
- A variety of dimensions need to be specified for species diversification to be properly defined and measured.

Remaining questions

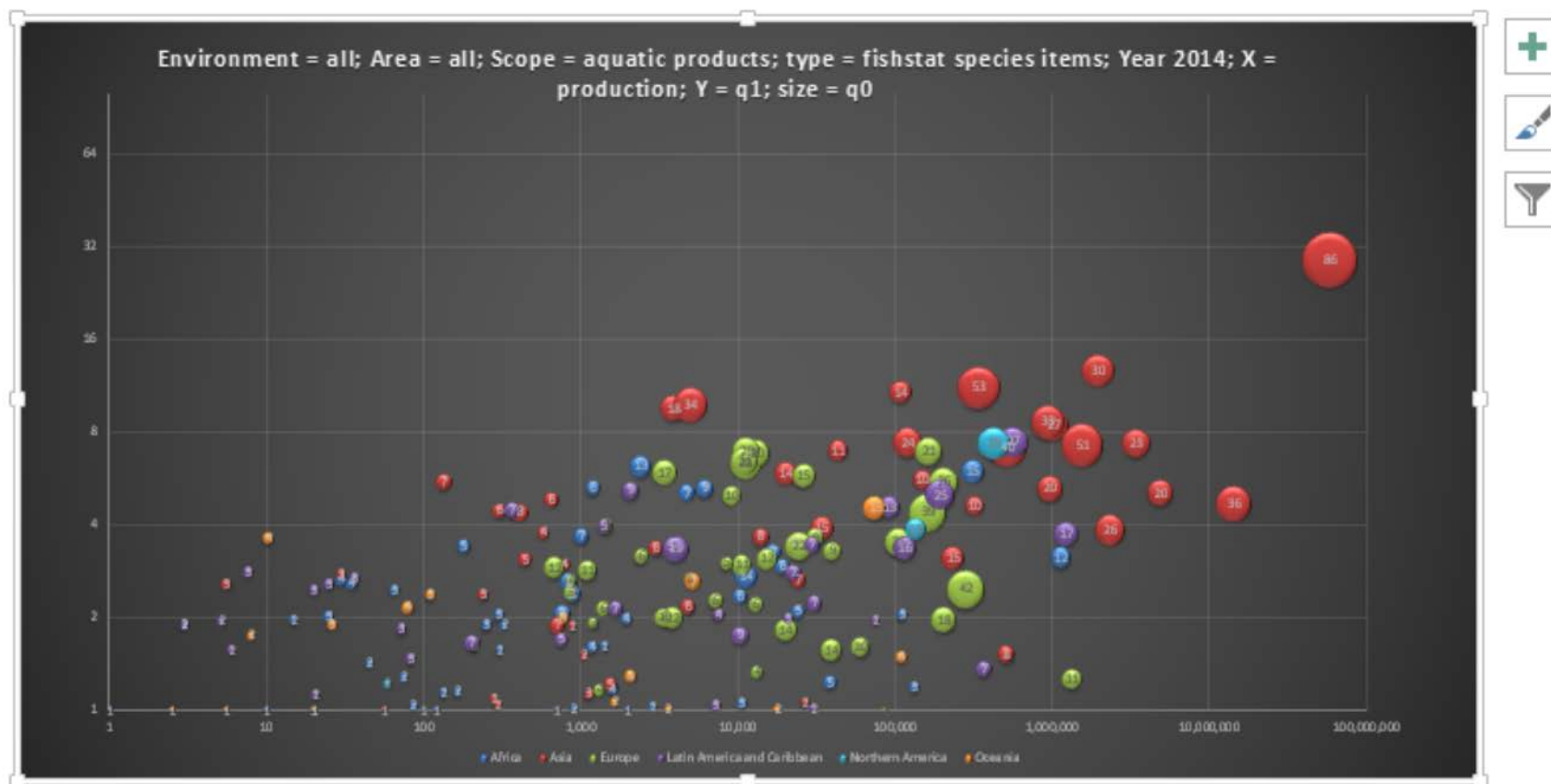
- How can a country learn from other countries' experiences in species diversification?
 - What can government learn?
 - What can the private sector learn?
- How do we know whether a certain species diversification pattern is good or bad for a country?
- What are other species diversification measures to use?
- How can species diversification measures be used to help government design proper aquaculture development strategies or make decisions on specific issues such as allocation of public funds to different research activities?
- How can species diversification measures help farmers select farming species?

Part IV: World Aquaculture Performance Indicators (WAPI)

Species diversification would become a feature template in the WAPI aquaculture production module

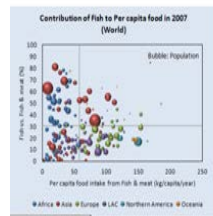
		Year	Variable	Adjustment
X		2014	production	
Y		2014	q1	
Size		2014	q0	1

Environment = all; Area = all; Scope = aquatic products; type = fishstat species items; Year 2014; X = production; Y = q1; size = q0



A prototype of World Aquaculture Performance Indicators: a user-friendly tool for evidence-based decision making

Contribution to Food & Nutrition: Global and Regional Overview			Unit	Source
Food & Nutrient	Per capita food	kg/capita/year		
Species	Fish			FAO-FI Fish FIS
Benchmark species	Fish & meat			FAOSTAT & FI FIS
Year	2007			
Calculate	World	Africa	Americas	
Summary table	Asia	Europe	Oceania	
Freeze	Unfreeze			MAIN MENU



Per capita food intake: Fish vs. Fish & meat in 2007			
Country	Per capita food intake from fish & meat (kg/capita/year)	Fish vs. Fish & meat (%)	Population (2007)
World	58.2	30.6	6,862,638
More developed regions	113.9	23.9	1,222,951
Less developed regions	45.5	36.9	5,440,687
Least developed countries	22.1	48.0	778,271
Landlocked developing countries	22.6	15.6	384,874
Small island developing States	55.6	28.8	41,752
Africa	24.3	35.5	914,034
Northern Africa	35.2	52.2	198,867
Algeria	25.2	20.4	33,907
Egypt	40.6	45.1	76,342
Liberia Arab Republic	36.1	23.0	6,023
Morocco	38.6	32.2	31,011
Tunisia	21.6	8.2	40,374
Tunisia	38.4	31.1	10,130
Western Sahara			480
Sub-Saharan Africa	21.9	35.4	709,860
Eastern Africa	15.2	36.1	386,969

• Scope

- 233 countries (or territories); 42 country groups; major species groups (FAOSTAT groups)

• Data sources utilized

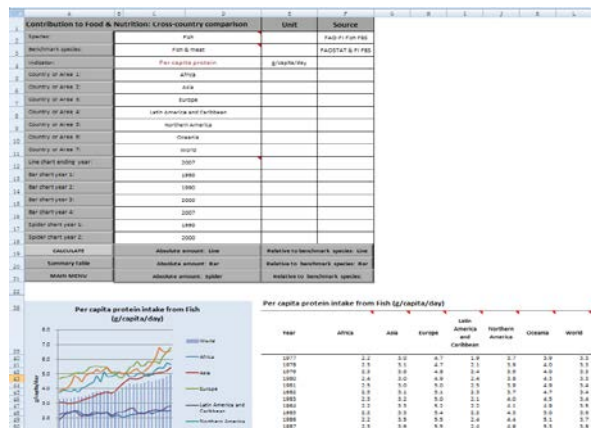
- FISHSTAT; Food Balance Sheet; FAOSTAT; UN Comtrade; UN Population; IMF WEO; World Bank WDI; FAO Statistics Division; ILO databases; China Fishery Statistics Yearbook; Global Aquaculture Performance Index (GAPI); FAO-INFOOD, among others.

• Data sources untapped

- FI data (land & water, employment, etc.); National fishery statistics; FATPs (feed, seed, small scale, etc.); Globefish; many others

• Components

- Selection menus; Tables & charts; Supporting materials (papers, websites, etc.)



Welcome collaboration on WAPI

FAO Fisheries and Aquaculture Report No. 1063

FIRA/R1063 (En)

ISSN 2070-0987

Report of the

**FAO EXPERT WORKSHOP ON ASSESSMENT AND MONITORING OF
AQUACULTURE SECTOR PERFORMANCE**

Gaeta, Italy, 5-7 November 2012



WAPI@fao.org

Thank You