

LENFEST OCEAN PROGRAM

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New tool for assessing the environmental performance of marine aquaculture

GAPI: GLOBAL AQUACULTURE PERFORMANCE INDEX

A SUMMARY OF NEW SCIENTIFIC ANALYSIS:

Volpe, J.P., M. Beck, V. Ethier, J. Gee and A. Wilson. 2010. Global aquaculture performance index. University of Victoria, Victoria, British Columbia, Canada.

FISH-FARMING, OR AQUACULTURE, is one of the fastest growing sectors of food production today. This global industry collectively produces more seafood than fishermen catch in the wild, highlighting the world's growing dependence on aquaculture production. The environmental impacts of one aquaculture sector, marine finfish farming, have raised questions about its sustainability. However, measuring and comparing the disparate environmental impacts of marine finfish aquaculture, such as water pollution, capture of wild fish for feed and the spread of fish diseases, has proven difficult.

In response, Dr. John Volpe and his research team, the Seafood Research Ecology Group, at the University of Victoria, British Columbia, Canada, have developed the Global Aquaculture Performance Index (GAPI). This tool incorporates current scientific understanding and marine finfish aquaculture data to provide the first comprehensive measure of the environmental performance of the marine finfish aquaculture industry globally. GAPI does not set standards for the aquaculture industry, but provides simple measures of environmental performance. Seafood retailers, buyers, producers and regulators can use the tool to quantitatively compare key environmental impacts of aquaculture across the global marine finfish industry. This *Lenfest Ocean Program Research Series* report is a summary of the scientists' methodology and current findings.

NORMALIZED VS. CUMULATIVE

Normalized scores measure the intensity of environmental impacts per unit of production. These scores level the playing field among producers of all sizes, so that direct comparisons can be made across countries or species no matter the amount of fish produced. In contrast, **cumulative scores** look at the overall impact of aquaculture production. Cumulative scores address the important questions of industry scale and carrying capacity in each region.

METHODS

The authors used methods derived from Yale and Columbia universities Environmental Performance Index, which ranks countries according to their scores across a number of environmental policy criteria. In the GAPI process, the researchers scored marine finfish across ten indicators of environmental performance considered to be the most significant and measurable for marine finfish aquaculture, such as the impacts on marine ecosystems of antibiotics used or number of escaped fish (see Figure 1). Using publically available data, the researchers were able to measure how close performance comes to a perfect score or zero impact (e.g., zero fish escape). They derived the overall score by summing scores from each indicator on a scale of 0–100, where a higher score indicates better environmental performance. While a perfect score may not be achieved by any species or country, the scoring system allows observers to clearly demarcate the leaders and laggards in each indicator and overall performance. Because the GAPI scoring system is based on how close an industry segment is to zero impact, it avoids the problem inherent in many standard-setting systems of deciding on a threshold score or performance that is "good enough."

To date, GAPI has assessed the top 20 marine finfish aquaculture species (by weight, in metric tons or mT), which comprise over 90 percent of global marine finfish aquaculture by volume and value (see Figure 2). The results are presented three ways: 1) by individual species, such as Atlantic cod; 2) by country, such as marine finfish farmed in Norway; and 3) by species-country pairs, such as Atlantic cod from Norway. To separate the effects of scale of production from impact per unit of production, GAPI also compares normalized scores (performance per mT of production) to cumulative performance (see side box).

FIGURE 1: GAPI ENVIRONMENTAL PERFORMANCE INDICATORS

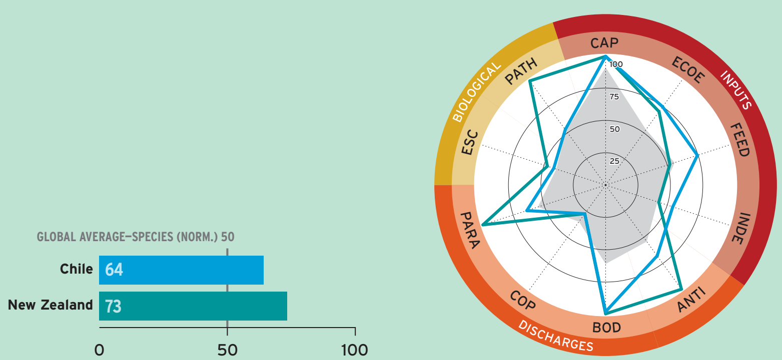
GROUPING	INDICATOR	INDICATOR DESCRIPTION
INPUTS	Capture-Based Aquaculture (CAP)	The extent to which a system relies on the capture of wild fish for stocking farms, taking into account the sustainability of these wild fish inputs
	Ecological Energy (ECOE)	Amount of energy, or net primary productivity (NPP), that farmed fish divert from the ecosystem through consumption of feed ingredients
	Industrial Energy (INDE)	Energy consumed in production and in the acquisition and processing of feed ingredients
	Sustainability of Feed (FEED)	Amount, efficiency and sustainability of wild fish ingredients in feed
DISCHARGES	Antibiotics (ANTI)	Amount of antibiotics used, weighted by a measure of human and animal health risk
	Antifoulants (Copper) (COP)	Estimated proportion of production using copper-based antifoulants
	Biochemical Oxygen Demand (BOD)	Relative oxygen-depletion effect of waste contaminants (uneaten feed and feces)
	Parasiticides (PARA)	Amount of parasiticides used, weighted by measures of environmental toxicity and persistence
BIOLOGICAL	Escapes (ESC)	Number of escaped fish, weighted by an estimate of the per capita risk associated with escapes
	Pathogens (PATH)	Number of on-farm mortalities, weighted by an estimate of wild species in the ecosystem that are susceptible to farm-derived pathogens

FIGURE 2: SPECIES AND COUNTRIES SELECTED FOR GAPI ASSESSMENT*

MARINE FINFISH SPECIES	PRODUCING COUNTRIES INCLUDED IN GAPI ANALYSIS
Atlantic cod	Iceland, Norway
Atlantic salmon	Canada, Chile, Norway, United Kingdom
Barramundi	Australia, Indonesia, Malaysia, Thailand
Bastard halibut	China, Republic of Korea
Chinook salmon	Chile, New Zealand
Cobia	China, Taiwan (Republic of China)
Coho salmon	Chile, Japan
European seabass	Greece, Italy, Spain, Turkey
Flathead grey mullet	Egypt
Gilthead seabream	Greece, Israel, Italy, Spain, Turkey
Groupers	China, Indonesia, Taiwan (Republic of China)
Japanese amberjack	Japan
Japanese seabass	China
Korean rockfish	Republic of Korea
Large yellow croaker	China
Milkfish	Indonesia, Philippines
Red drum	China
Red seabream	China, Japan
Tiger pufferfish	China, Japan
Turbot	France, Spain

**These species represent 90% of marine finfish produced in 2007.*
Data source: FAO FishStat, www.fao.org/fishery/statistics/software/fishstat/en.

FIGURE 3: CHINOOK SALMON PERFORMANCE



RESULTS

The results for each species and country are presented in radar graphs (see Figure 3), where each of the ten spokes on the wheel represents a different indicator. The center point represents a score of zero, while the outermost ring represents a score of 100. Thus, a radar graph of a perfect GAPI score would look like a perfectly round wheel. Because the total GAPI score is a weighted average of the individual indicators, these radar graphs can be used to pinpoint where each performer excels and falls short, in addition to where improvements would have the biggest impact.

GAPI scores reveal tremendous variation in environmental performance. Normalized species-country scores ranged from a very low score of 10 (grouper from Indonesia) to a mediocre score of 73 (chinook salmon from New Zealand). On a cumulative level, GAPI scores ranged from a low of 19 (Japanese seabass from China) to 96 (turbot from France). However, the GAPI score calculation methodology results in scores that are relative to the group of performers being assessed, rather than absolute scores. Thus, the inclusion of additional species or different types of production systems would realign GAPI scores. The full list of normalized and cumulative scores reported by species, country and species-country pairs can be found at www.gapi.ca.

CONCLUSIONS

- **Sustainability must be demonstrated, not assumed.** Before GAPI, assessing aquaculture sustainability relied largely on qualitative data; however, the availability and quality of data for quantitative assessment is inconsistent. Increasing the use of quantitatively rigorous assessments, such as GAPI, in policy and production decisions will benefit the ecological and economic viability of the industry over the long term.
- **Not all marine finfish aquaculture is the same.** GAPI scores reveal tremendous variation in environmental performance within the marine finfish sector. These variations are highlighted in species-country pair scores, countries scores and species scores.
- **There is substantial room for improvement**. GAPI scores are scaled to the group under assessment, so that high scores mean that a species or country is doing better than the others in the group (i.e. other marine finfish), but may still be a long way from ideal performance. Even the strongest performers are about 30 points from the aspirational score of 100, suggesting the environmental performance of the entire marine finfish farming sector could benefit significantly from improvement.

- **The worst-performing sectors of the industry are also the fastest-growing**. Marine finfish farmed in tropical and sub-tropical waters such as groupers, red drum and cobia have some of the worst scores on both normalized and cumulative levels, yet production of these three species has grown over 40 percent per year for the last five years on record.
- **Asian countries play a large role.** Asian countries account for the 15 lowest species-country scores. However, Asian cumulative scores improve relative to normalized scores by virtue of the modest production in those countries.
- **Scale matters.** The sheer scale of production can have dramatic effects on environmental performance. For example, Atlantic salmon is the third-highest ranking species on a per unit of production basis (normalized score, 70), but when production volume is taken into account, Atlantic salmon's score drops almost 50 percent. In other words, massive production of a higher-performing species could create more environmental damage than a handful of small, poorly performing farms.

Paths forward

Charting a sustainable course for marine aquaculture requires understanding the full suite of trade-offs among its economic, social and ecological benefits and consequences, as well as identifying impacts at a finer scale. GAPI is intended to both inform and stimulate discussion of the appropriate metrics for evaluating performance and to drive the gathering and sharing of data. While the 2010 GAPI report provides a snapshot in time of environmental performance, the GAPI Web site (www.gapi.ca) is the repository for the wider body of data and analyses that will be updated as additional or better data become available. User feedback is encouraged and will be incorporated into the online tool.

About the Authors

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The SEAFOOD ECOLOGY RESEARCH GROUP (SERG) at the University of Victoria is an interdisciplinary team whose research is focused on the inevitable challenges arising from the limited capacity of marine systems to produce seafood and the seemingly limitless capacity for humans to consume those products. SERG uses scientific approaches to link ecological and social sustainability with regard to marine-based food production systems.

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The Lenfest Ocean Program supports scientific research aimed at forging new solutions to the challenges facing the global marine environment.

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