WWF CANADA

FOOD FOR ALL

Small fish with big influence

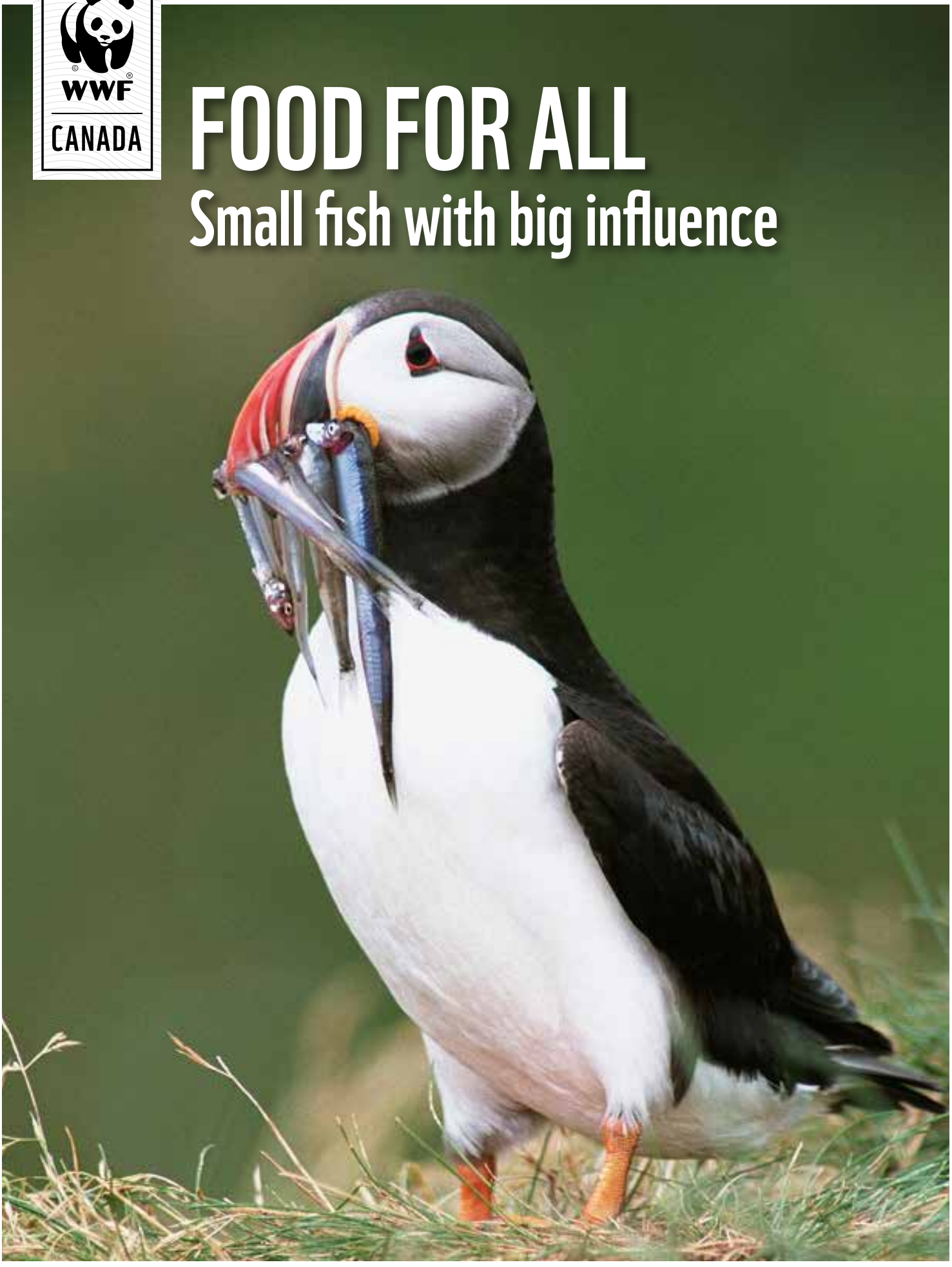


Photo: © WWF-Canada, National Geographic Stock / Paul Nicklen

Pacific herring, British Columbia

Why do forage fish matter?

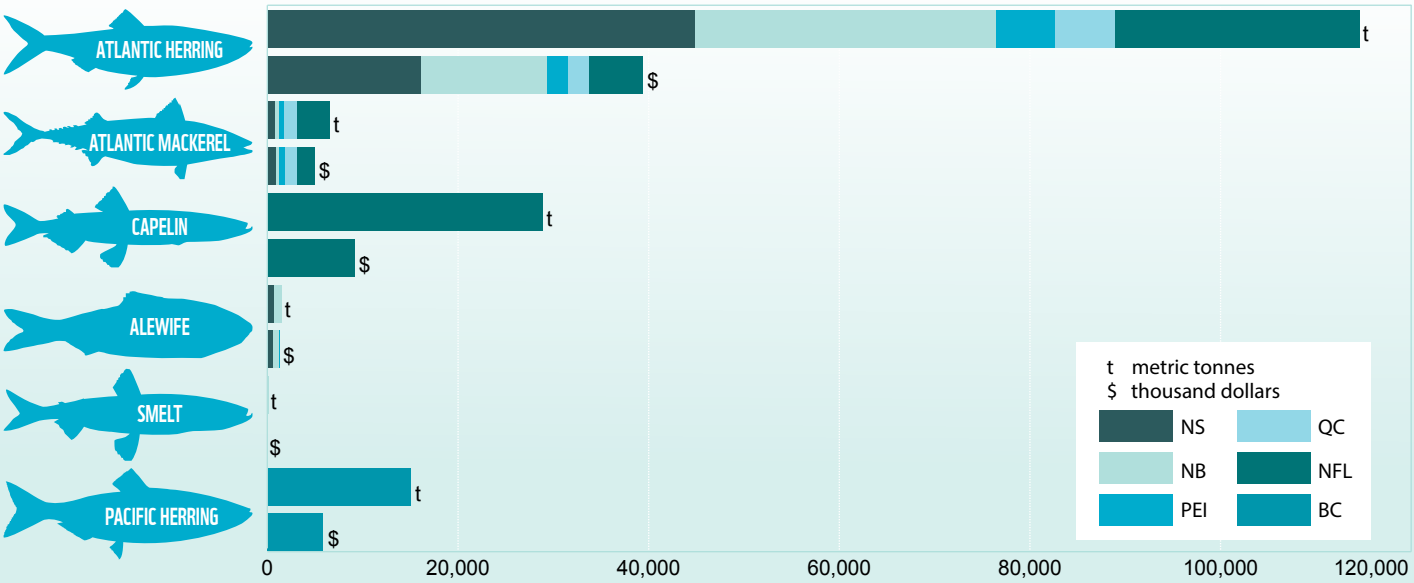
Forage fish, such as herring and capelin, are small to intermediate size marine prey species that are eaten by a huge range of marine predators, including whales, seals, big fish like tuna and cod, and seabirds. These big predators are key elements in ocean health, and they need a lot of food.

Vulnerable

Forage fish are often the most abundant component of marine ecosystems by number and weight. However, they remain very vulnerable to overfishing. Worldwide, twice as many small, low-trophic level fish stocks have collapsed compared to large predatory fish stocks (Pinsky et al., 2011). Here is why:

- Forage fish abundances can fluctuate greatly from year to year because of changes in environmental conditions. Intense fishing can exacerbate the rate of decline (Essington et al., 2015).
- Even when their abundance decreases, forage fish remain easy to harvest as they aggregate in large shoals (Essington et al., 2015).
- Conventional management approaches do not account for the large natural fluctuations or the role forage fish play in marine ecosystems. (Pikitch et al., 2012).

Commercial forage fish species catch and value 2014 in Canada



Information from http://www.dfo-mpo.gc.ca/stats/commercial/sea-maritimes-eng.htm

***Cover:** Atlantic puffin, Witless Bay Ecological Reserve, Newfoundland*
Photo: © WWF-Canada/Frank Parhizgar

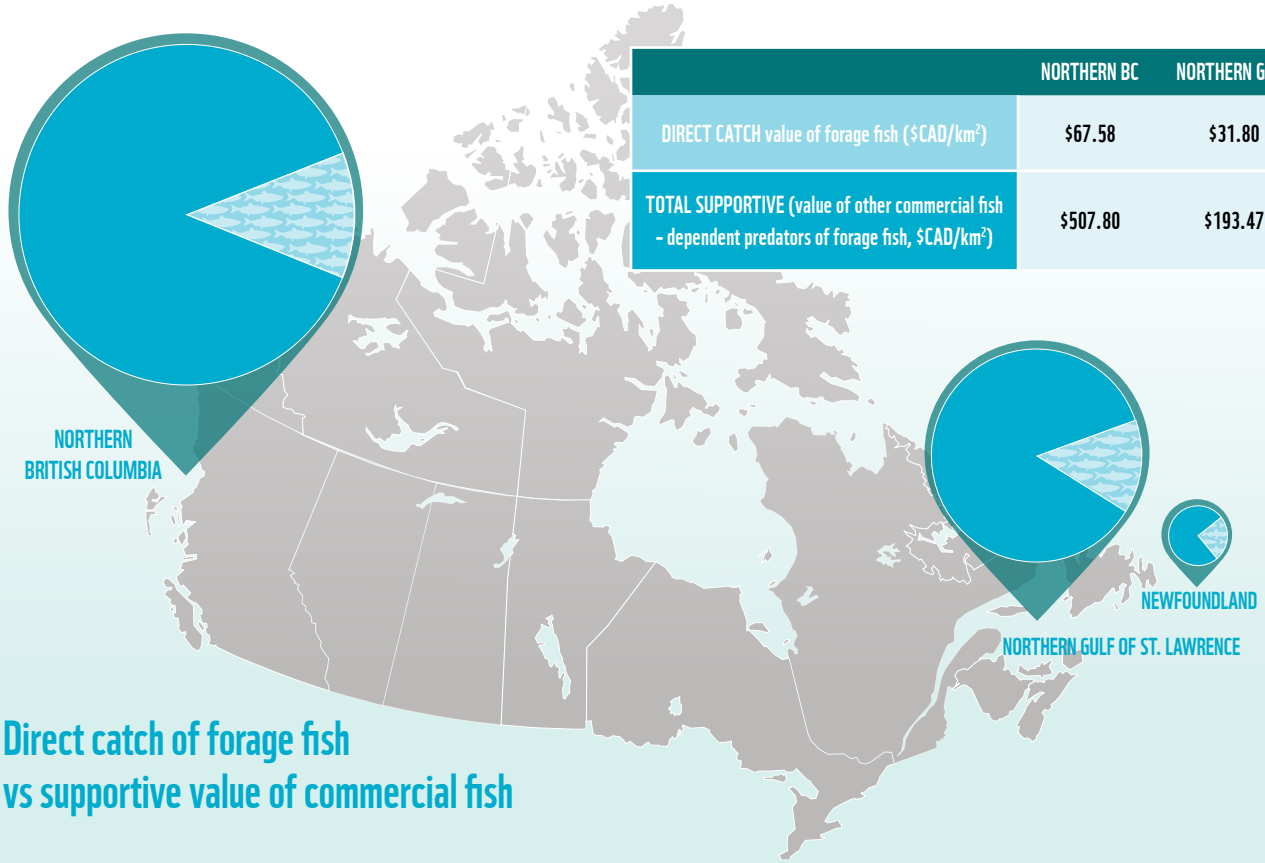
More valuable in the water

In temperate and high latitude ecosystems, like Canada, the economic value of forage fish as prey for other commercially harvested species, such as Atlantic cod and bluefin tuna, is more than double the value of the direct forage fish catch (i.e., fisheries that specifically target species such as herring) (Pikitch et al., 2014). Moreover, forage fish support many seabird and whale populations that in turn support vital tourism industries.

Photo: © WWF-Canada/ Gilbert Van Ryckevorsel

Northern bluefin tuna, Nova Scotia

	NORTHERN BC	NORTHERN GULF	NEWFOUNDLAND
DIRECT CATCH value of forage fish ($CAD/km^2)	$67.58	$31.80	$4.33
TOTAL SUPPORTIVE (value of other commercial fish - dependent predators of forage fish, $CAD/km^2)	$507.80	$193.47	$13.43



Direct catch of forage fish vs supportive value of commercial fish

One-third for the birds rule

When forage fish abundance falls below approximately one-third of the long-term biomass, the breeding success of several seabird populations worldwide starts to decline (Cury et al., 2011). In Atlantic Canada, northern gannet breeding failure is directly linked to the decline of Atlantic mackerel – their favourite prey during the chick-rearing period (Guillemette et al., in prep). For these birds, competition from fisheries has increased over time as the mackerel stock has declined. This stock is currently overfished: the Total Allowable Catch is currently 10 times higher than the level proposed by scientific advisors (DFO, 2009). One adult gannet can consume up to 438g of mackerel daily. In the Gulf of St. Lawrence, the total mackerel requirement of these birds is estimated to be 8,000 t/yr Guillemette et al., in prep).

Northern gannet, Newfoundland Photo: © WWF-Canada/Alan Burger

Dependent predators

The greater its dependence on forage fish, the more vulnerable a predator is to changes in forage fish abundance. Consequently, a reduction in available prey through fishing, natural environmental fluctuations, climate change or a combination of these factors can induce changes throughout the food web, altering the function and structure of marine ecosystems (Pikitch et al. 2012).

Atlantic puffin, Witless Bay Ecological Reserve, Newfoundland

There are four classifications of dependent predators:

EXTREME DEPENDENCE > 75 per cent of their diet is composed of forage fish	HIGH DEPENDENCE 50 per cent to < 75 per cent	MODERATE DEPENDENCE 25 per cent to < 50 per cent	LOW DEPENDENCE < 25 per cent of their diet
CAPELIN Humpback whale Fin whale Minke whale Harbour seal Greenland halibut	Common murres Gannets Puffins Razorbills Gulls Shearwaters Fulmars feed Mackerel Mesopelagics Short-finned squid Large Atlantic cod	American plaice Harp seal	Arctic cod
ATLANTIC HERRING	Bluefin tuna Harbour porpoise Swordfish	Large Atlantic cod Blue shark Demersal piscivores fish Silver hake Dogfish Seabirds Porbeagle shark Fin whale Pollock	Humpback whale Small Atlantic cod Halibut White-sided dolphin Sei whale
PACIFIC HERRING	Copper rockfish Quillback rockfish Tiger rockfish China rockfish Yelloweye rockfish	Lingcod (adult) Chinook salmon Stellar sea lion Harbour seal Pacific cod (adult) Coho salmon	Gulls Grebes Cassin's auklet Tufted puffin Common murre Rhinoseros aucklet Marbled murrelet Pigeon guillemot Merganser Pelagic cormorants Sooty shearwater Northern fulmar Double-crested cormorant Common loon Dogfish Turbot (adult) Piscivorous rockfish (adult) Halibut (adult)

Humpback whales feeding in coastal waters near Prince Rupert, British Columbia.

Canadian forage fisheries assessment

In 2012, the Lenfest Forage Fish Task Force, a group of 13 prominent fisheries scientists from around the world, published a comprehensive report on forage fish fisheries (Pikitch et al. 2012).

The group synthesized existing literature, examined current and past management practices, and compiled empirical data from case studies on the impacts of forage fish fisheries on ecosystem dynamics and predator dependence. The report provided a set of recommendations based on a three-tiered management framework – low, intermediate and high – according to the amount of information available for a particular fishery or ecosystem.

Fisheries were evaluated against two main categories:

1. **Forage fish stock dynamics and fisheries**, including information about population abundance, status, trends, environmental drivers and monitoring
2. **Dependent predators**, including information about population abundance, trends and foraging grounds.

The overall management strategy goal was to regulate fishing intensity so that there was a low risk of significantly affecting dependent predators (see table 7.1, p.90 in Pikitch et al. 2012).

Based on this framework, an assessment matrix was developed to evaluate Canadian forage fish fisheries (Table 1).

A 'fishery' here refers to the individual managerial unit/component as defined by current management.

For each fishery, a summary card was compiled with the relevant information used in the assessment and scoring.

Table 1: Three-tiered assessment matrix with score criteria (from 0 to 2) used to evaluate Canadian forage fish fisheries.

Each criteria were either directly taken from the Lenfest Forage Fish Task Force recommendations (table 7.1, p.90 in Pikitch et al., 2012) or adapted based on best practices and the Canadian Fishery Decision-Making Framework Incorporating the Precautionary Approach (DFO, 2016).

SCORE (LOW TO HIGH)	0	1	2
Monitoring (LENFEST)	Monitoring and enforcement are not sufficient	Some monitoring and enforcement so that catches are likely to be within limits	High ability to monitor and enforce regulations
Environmental drivers (LENFEST)	Environmental drivers have not been examined	Some environmental drivers of forage fish productivity were identified	Environmental drivers are well known and are accounted for
Fishery-independent index	None	Partial (spatial, temporal)	Annual and complete spatial coverage (as much as possible)
Reference points defined	None/obsolete	Partial/others	Yes
Harvest Control Rules	Total allowable Catch (TAC) is specified but no HCRs are in place/available	Defined HCRs are in place to keep the stock fluctuating around a target level	The HCRs are expected to keep the stock fluctuating at or above a target level consistent with ecosystem needs
Stock Status	Critical Zone	Cautious Zone	Healthy Zone
Predators (LENFEST)	Dependent predators have not been identified	Dependent predators have been identified so that effects of forage fish on their abundance can be predicted on the basis of food web models	The functional responses of dependent predators to forage fish abundance are well defined based on empirical evidence from the relevant ecosystem so that effects of fishing can be determined with a high degree of certainty
Predators population (LENFEST)	Evidence is insufficient to judge the status and trends either known or likely to be dependent upon forage fish.	Population status and trends of dependent predators are monitored but with considerable uncertainty.	Population status and trends are measured with high certainty and at frequent intervals.
Predators/foraging (LENFEST)	Spatial patterns of foraging are not known.	Spatial patterns of foraging are known and sufficient to support predictions about the effects of localized depletion.	Localized forage fish requirements of dependent predators can be estimated with high precision.

Fishing boats harvesting Atlantic herring from a fixed weir, Bay of Fundy

Photo: © WWF-Canada/Barrett&Mackay

Results of the assessment

Only the main forage fish commercially harvested in Atlantic Canada (14 herring, four capelin, and one mackerel stocks/units) were analyzed, for a total of 19 stocks/units. In Pacific Canada, herring is the main commercial forage fish species harvested. It is currently managed as five major and two minor stock areas, among which Haida Gwaii and the West Coast of Vancouver Island are currently closed to fishing. Pacific sardine and surf smelt were also subjected to small commercial fisheries, but no catches have been recorded since 2013. In total, across Canada, 27 fisheries were assessed.

Monitoring

Most fisheries are managed under an Integrated Fisheries Management Plan with monitoring requirements that may have included logbook reporting, dockside monitoring and at-sea observer coverage. If monitoring was not explicitly raised as a potential issue in the Department of Fisheries and Oceans (DFO) proceedings and scientific reports, the fishery received a high score. Unreported and unmanaged catches from bait and recreational fisheries remain a serious concern for the Atlantic mackerel fishery in the Maritimes.

Environmental drivers

Environmental conditions were rarely considered in current population assessments of fisheries, and when data were available, these conditions were largely overlooked in advising management.

Fishery-independent surveys

Fishery-independent surveys provide the basis for estimating population biomass, developing population models, estimating reference points and developing harvest control rules. Currently, larger herring fisheries and the Atlantic mackerel fishery have dedicated surveys; however, one third of the fisheries (9/27) are not regularly assessed and current scientific information is insufficient to advise fisheries management.

Reference points

Nearly three-quarter of the fisheries (20/27) do not have defined reference points according to the Precautionary Approach.

Harvest control rules

Total allowable catches (TAC) were developed for several stocks, but there are no generally pre-agreed upon harvest control rules in place for managing the fisheries in the different stock status zones (when available) according to the Precautionary Approach.

Stock status

Twenty-one fishery stock statuses remain unknown according to the Precautionary Approach, including the four capelin fisheries in Atlantic Canada and herring fisheries in Newfoundland and British-Columbia. Three fisheries are in the critical zone, including the two spring Atlantic herring stock components in the Gulf St. Lawrence and Atlantic mackerel across the Maritimes region. Other fisheries of concern include the Atlantic herring Southwest Nova Scotia/Bay of Fundy, Atlantic herring in Fortune Bay, N.L. and the Pacific herring in Haida Gwaii. For all these fisheries, an important factor in the decline was attributed to changes in the environment.

Predators

In each marine ecoregion of Canada there was at least one ecosystem-model that provided some information on dependent predators. However, many top predators, like whales and seabird species, remain aggregated into larger functional groups, such as the baleen whales, the toothed whales and seabirds, and in some ecoregions, forage species were aggregated, so that the predators' functional responses to forage fish abundance remain poorly understood.

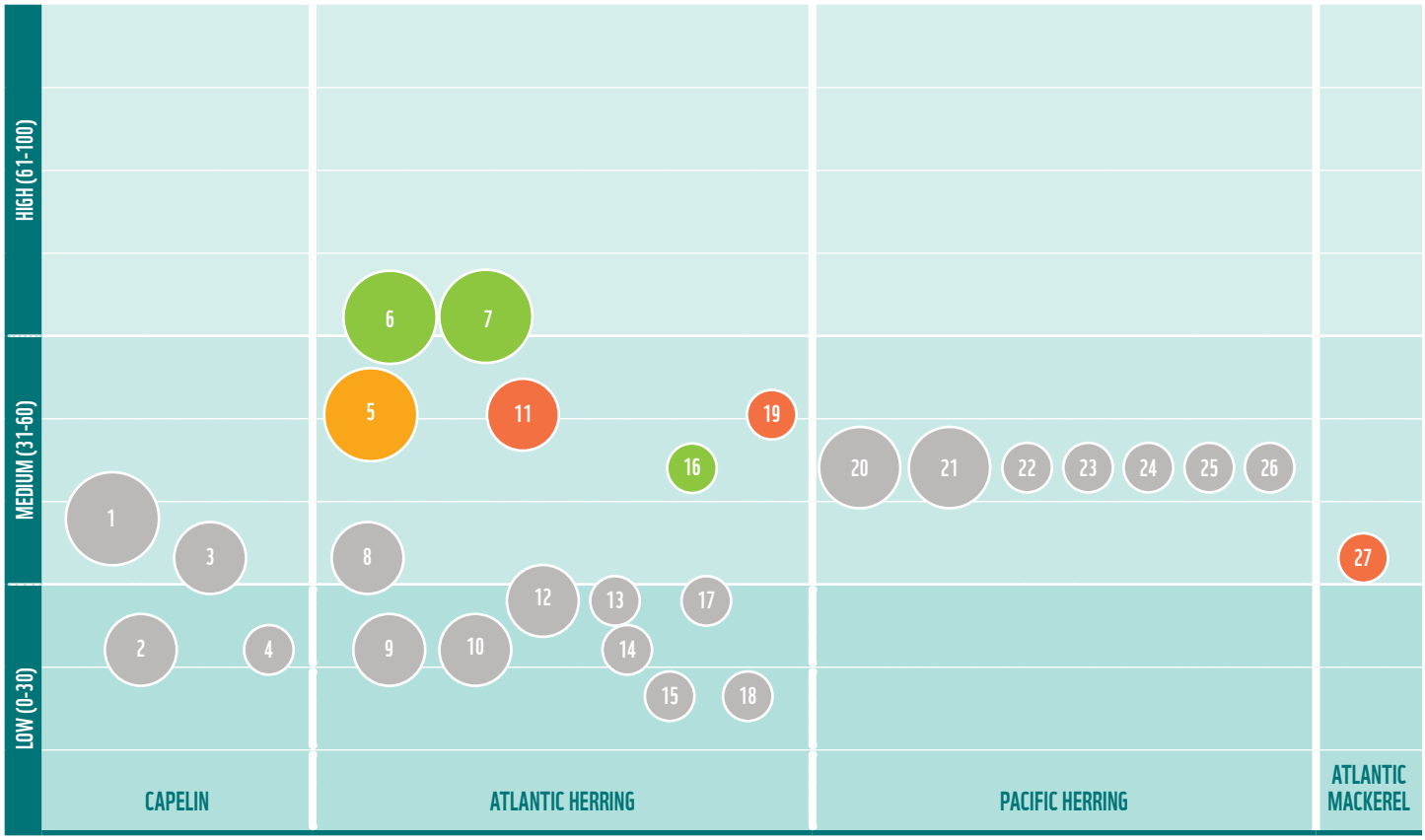
Predator populations

Fishery-independent surveys for finfish, marine mammals and seabirds are conducted annually by DFO. The population statuses and trends of dependent predators are monitored but remain largely unreliable for some species.

Predators/foraging

Based on available data, the spatial patterns of foraging by dependent predators were not sufficiently understood for predicting the potential effect of localized depletion (i.e., when intense harvesting reduced forage fish abundance levels in a defined area and time period); hence, all fisheries received a low score.

Final score (over 18 points) in percentage for the 27 fisheries included in the assessment



LEGEND

LANDINGS IN METRIC TONNES (t)

< 1,000t | 1,000-10,000t | > 10,000t

STATUS

Healthy | Cautious | Critical | Unknown

FISHERY

1 Capelin Newfoundland, NAFO 2J3KL
2 Capelin Gulf, NAFO 4R
3 Capelin Newfoundland, NAFO 3Ps
4 Capelin Gulf, NAFO 4ST
5 Atlantic herring, Southwest Nova Scotia/Bay of Fundy, NAFO 4WX
6 Atlantic fall herring, West of Newfoundland, NAFO 4R
7 Atlantic fall herring, Southern Gulf of St. Lawrence, NAFO 4TVn
8 Atlantic herring, Bonavista Bay - Trinity Bay
9 Atlantic herring, Northern Gulf of St. Lawrence, NAFO 4S
10 Atlantic herring, Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia spawning, NAFO 4VnWX
11 Atlantic spring herring West of Newfoundland, NAFO 4R
12 Atlantic herring, Offshore Scotian Shelf Banks Spawning, NAFO 4VsWX
13 Atlantic herring, Fortune Bay and Pass Island/Cinq Cerf, NAFO 3Ps
14 Atlantic herring, St. Mary's Bay-Placentia Bay
15 Atlantic herring, Southern Labrador, NAFO 2*
16 Atlantic herring, Southwest New Brunswick migrant juveniles**
17 Atlantic herring, White Bay - Notre Dame Bay
18 Atlantic herring, Conception Bay-Southern Shore
19 Atlantic spring herring, Southern Gulf of St. Lawrence, NAFO 4TVn
20 Pacific herring, Strait of Georgia
21 Pacific herring, Prince Rupert District
22 Pacific herring, Central Coast
23 Pacific herring, Area 2W
24 Pacific herring, Area 27
25 Pacific herring, Haida Gwaii
26 Pacific herring, West Coast Vancouver Island
27 Atlantic mackerel, NAFO 3 and 4

*Exploratory fishery with a separate quota, but the stock may belong to White Bay-Notre Dame Bay
**Managed by the U.S.A.

Photo: WWF-Canada/© Gilbert Van Ryckevorsel

WWF-Canada recommendations

Atlantic mackerel, Canada

RECOGNIZE the importance of forage fish in the ecosystem and their critical role in maintaining populations of other commercial and non-commercial species.

IMPLEMENT a modern, ecosystem-based fisheries approach – one that considers the needs of multiple species, as opposed to a single stock – to ensure the long-term viability of forage fish stocks and dependent predators.

URGENTLY

- Address issues related to unrecorded landings in the recreational and bait fisheries, specifically for the Atlantic mackerel fishery in Atlantic Canada and implement recreational catch control regulations similar to those in Pacific Canada
- Quantify predator-prey dynamics affected directly or indirectly by forage fish fisheries, focusing on species at risk and predators with high-to-extreme dependence (over 50 per cent of their diet composition)
- Apply the precautionary principle by setting reference points and pre-agreed harvest control rules to ensure both the sustainability of the target species and the food supply for predators

APPLY Canada's Policy on New Fisheries for Forage Species (April 2009) to all existing Canadian forage fisheries.

PROTECT the health of forage fish stocks by increasing research capacity and monitoring programs to:

- Identify environmental factors to enable forecasts of stock dynamics
- Undertake fishery-independent monitoring, such as acoustic surveys, to provide adequate information for developing population models and setting limit reference points
- Define areas of potential "localized depletion," and where necessary applying spatial management to minimize effects on dependent predators, particularly on more spatially constrained species, such as seabirds

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