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Changements dans les caractéristiques biologiques des pêches du golfe du Saint-Laurent (Divisions 4RST de l'OPANO) depuis 1960.

Changes in biological characteristics of the fisheries of the Gulf of St. Lawrence (NAFO Divisions 4RST) since 1960.

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RÉSUMÉ

Les caractéristiques biologiques des espèces de poissons et d'invertébrés pêchés dans le golfe du Saint Laurent (Divisions 4RST de l'OPANO) montrent des changements importants depuis les années 1960 à maintenant. Ces changements sont caractéristiques d'une surpêche qui réduit initialement les plus gros individus prédateurs à longue longévité pour aboutir après 43 ans à une pêche qui s'effectue sur de plus petits individus à courte longévité. Ces tendances résultent de l'effondrement des stocks de morue et de sébaste et de l'augmentation récente de la pêche à la crevette, au homard et au maquereau. La flotte des engins mobiles contribue à 72% des débarquements de 1960 à 1985 mais seulement à 40% des débarquements de 1995 à 2002. Ceci reflète un changement d'espèce visée des grands démersaux vers les petits pélagiques et invertébrés qui sont principalement capturés par engins fixes.

ABSTRACT

The biological characteristics of fish and invertebrates harvested in the Gulf of St.-Lawrence (NAFO Divisions 4RST) show important changes from the 1960s to the early 2000s. These changes are characteristic of over exploitation which initially harvested large predators with long life span to end up 43 years latter with a fishery that takes place on small specimens with short life span. This is essentially due to the collapse of cod and redfish stocks and a recent increase in the fisheries for shrimp, lobster and mackerel. The mobile fleet was responsible for 72% of the landings between 1960 and 1985 but only 40% of the landings between 1995 and 2002. This reflects changes in target species from large demersals to smaller pelagic fish and invertebrates which are primarily exploited with fixed gear.

Introduction

Les publications qui lient les activités de pêche à des indicateurs des communautés ont augmenté récemment (ICES, 2005, Piet and Jennings, 2005, Daan *et al*., 2005, Shin *et al*., 2005). La pêche a une forte probabilité d'être responsable des changements de la structure des communautés, mais il est possible qu'il y ait des influences telles que le changement climatique, des changements décadaux ou des changements dans l'indice d'oscillation Nord Atlantique (NAO) (Brander et Mohn, 2004). Certaines pêcheries ont pu se développer à cause de revenus plus importants.

Le golfe du Saint Laurent est une zone appropriée pour considérer les effets de la pêche sur l'écosystème car il s'agit d'une mer intérieure (Therriault, 1991) où la plupart des espèces commerciales, à l'exception du maquereau, sont considérées comme des stocks distincts de ceux de l'Atlantique (Levasseur, 1996, White et Jones, 1997). L'effort de pêche pour plusieurs stocks est généralement assez élevé et plusieurs stocks ont connu de grandes variations des débarquements au fil des ans. L'effondrement récent du poisson de fond a mené à plusieurs moratoires (morue et sébaste) ainsi qu'à des régions fermées à la pêche (pour le crabe : zone 13 de la Basse Côte Nord du Québec). Une augmentation régulière à la fois de la biomasse et de la pêche à la crevette nordique (*Pandalus boréalis*) est associée à ces récents déclins de poissons démersaux, principaux prédateurs de la crevette. Le but de la présente analyse est de décrire l'ensemble des débarquements à l'aide de caractéristiques biologiques propres à chacune des espèces pêchées et de suivre leur tendance temporelle depuis les années 1960 à maintenant.

Introduction

The field of linking fishing to community indicators, have flourished in the literature recently (ICES, 2005, Piet and Jennings, 2005, Daan *et al*., 2005, Shin *et al*., 2005). Although fishing has a very high likelihood of being responsible for the changes in community structure, there is still the possibility of influences from climate change, decadal cycles or changes in the North Atlantic Oscillation (NAO) index (Brander and Mohn, 2004). New fisheries have also developed because of lucrative revenues in a changing market.

The Gulf of St. Lawrence is an appropriate area to consider ecosystem effects of fishing practices as it is an enclosed sea (Therriault, 1991) where almost all commercial species, except mackerel, are considered as separate stocks from the Atlantic (Levasseur, 1996, White and Jones, 1997). Fishing effort is for most stocks generally quite high and many fisheries have known large fluctuations in landings through time. The more recent collapse of groundfish has led to many moratoriums (cod and redfish) and in certain areas, crab (zone 13 on the Lower-North Shore of Quebec). A gradual increase in biomass and fishery of northern shrimp (*Pandalus borealis*) is associated with the recent decline in groundfish, main predators of shrimp. The purpose of this analysis is to examine the time series of the commercial fishery data through their biological characteristics unique to each specie fished and to follow the temporal trend since the 60s.

Matériel et méthodes

Toutes les statistiques de débarquements annuels de poissons de fond, pélagiques et d'invertébrés ont été extraites de la base de données de la FAO pour la période de 1960 à 2003 (Tableau 1). Les phoques, baleines et oiseaux marins ne sont pas inclus dans cette analyse.

Une seconde base de données concernant 14 caractéristiques biologiques pertinentes pour les 53 espèces sélectionnées a été réalisé à partir de l'inventaire de FishBase (Froese et Pauly, 2005) (Tableau 2). Les valeurs pour les invertébrés ont été extraites à partir du site « Sea around us ». Une description de comment ces caractéristiques ont été calculées est donnée en annexe 1. Ces caractéristiques biologiques sont les suivantes :

Material and methods

All annual commercial fishery statistics for groundfish, pelagics, marine invertebrates and anadromous species for the Gulf (4RST) were extracted from the FAO database for the period 1960 to 2003 (Table 1). Seals, whales and marine birds are not included in this analysis.

A second database was constructed with 14 biological characteristics of relevance to the 53 selected species (Table 2). Values for fish were extracted from FishBase (Froese and Pauly, 2005), values for invertebrates were extracted from "Sea around us project" web sites. A description of how these characteristics were derived is given in annex 1. These biological characteristics are as follows:

1. Niveau trophique
2. Taille maximum
3. Âge à la première maturité
4. Longévité
5. Temps de génération
6. Taux de croissance
7. Taux intrinsèque de croissance
8. Longueur au rendement maximum
9. Rendement par recrue relatif
10. Mortalité naturelle
11. Fécondité
12. Consommation
13. Azote et protéine
14. Résilience

Un des paramètres importants est le niveau trophique. Les diverses espèces qui caractérisent un écosystème peuvent être catégorisés dans cinq grands groupes. En fait, dans la nature, ces valeurs sont continues, les espèces peuvent donc avoir une valeur continue entre 1 et 5. Notez que certaines variables ont des corrélations élevées (Tableau 3).

Une valeur annuelle moyenne de chaque caractéristique a été calculée en pondérant les diverses caractéristiques biologiques par espèce par les débarquements.

$$\overline{C_t} = \sum_{sp=1}^{53} (C_{sp} \times Deb_{sp,t}) \div (\sum_{sp=1}^{53} Deb_{sp,t})$$

Où :

$\overline{C_t}$ = Caractéristique moyenne de toutes les espèces pêchées durant l'année $_t$.

C_{sp} = Valeur de la caractéristique biologique de l'espèce $_{sp}$.

$Deb_{sp,t}$ = Débarquements de l'espèce $_{sp}$ durant l'année $_t$.

La description de l'évolution des débarquements fait par engins mobiles a été réalisée à partir des fichiers STATLANT 21b de l'OPANO. Les données de 2003 étaient incomplètes lors de cette analyse. Les gammes de codes d'engins mobiles retenus variaient de 9 à 23.

Résultats

Le total des débarquements de 52 pêcheries du golfe du Saint-Laurent (Divisions 4RST, Figure 2) oscille généralement entre 200 000 t et 300 000 t à l'exception d'un premier pic en 1970 suivi d'une seconde période de valeurs importantes à la fin des années 70 et la fin des années 80 (Figure 3). Par

1. Trophic level
2. Maximum length
3. Age at first maturity
4. Longevity
5. Generation time
6. Growth rate
7. Intrinsic growth rate
8. Length at maximum yield
9. Relative yield per recruit
10. Natural mortality
11. Fecundity
12. Consumption
13. Nitrogen and protein
14. Resilience

One important biological parameter concerns the trophic level. Individual species of an ecosystem can be categorized into five major groups. These are shown in a diagram (Figure 1). In fact, the categories are continuous in nature, individual species of the marine ecosystem can be given a continuous range of values between 1 and 5. Note that some variables are highly correlated (Table 3).

A yearly average value for each biological characteristic was calculated by weighting the species specific characteristic by the landed weight.

$$\overline{C_t} = \sum_{sp=1}^{53} (C_{sp} \times Land_{sp,t}) \div (\sum_{sp=1}^{53} Land_{sp,t})$$

Where:

$\overline{C_t}$ = Average characteristic of all species fished in year $_t$.

C_{sp} = Value of the biological characteristic of specie $_{sp}$.

$Land_{sp,t}$ = Landing of specie $_{sp}$ in year $_t$.

The description of the changes in mobile gear landings were extracted from NAFO STATLANT 21b statistics. Data for 2003 were incomplete for this analysis. The mobile gear codes retained ranged from 9 to 23.

Results

Total landings from Gulf fisheries (Divisions 4RST, Figure 2) generally fluctuate between 200,000 t and 300,000 t with the exception of a first peak in 1970 and a second period of important landings at the end of the 70's until the end of the 80's (Figure 3). However, significant changes in species contre, des changements importants dans la composition des espèces pêchées dans le golfe du Saint-Laurent sont observés durant cette période (Figure 4). Le premier pic est associé aux débarquements importants de hareng (*Clupea harengus*), morue (*Gadus morhua*) et de sébaste (*Sebastes spp*.) alors que la seconde période de débarquements importants est surtout associée à la morue, puis au hareng (Figure 4). Même si leurs débarquements fluctuent dans le temps, quatre espèces de poissons (hareng *Clupea harengus*, morue *Gadus morhua*, sébaste *Sebastes spp*. et maquereau *Scomber scombrus)* et trois espèces d'invertébrés (homard *Homarus americanus*, crevette nordique *Pandalus borealis* et crabe des neiges *Chionocetes opilio*) constituent les principales espèces pêchées dans le Golfe. Les débarquements de hareng, de maquereau et de crabe ont augmenté beaucoup au cours des années 2000 (Figure 4). Les débarquements de homard sont importants et assez stables depuis le milieu des années 80. L'importance de la crevette dans les débarquements augmente régulièrement depuis le début de sa pêche en 1966.

compositions of the fisheries occur during that period in the Gulf of St. Lawrence (Figure 4). The first peak is associated with important landings of herring (*Clupea harengus*), cod (*Gadus morhua*) and redfish (*Sebastes spp*.) while the second period is mostly due to cod, then herring (Figure 4). Although their landings fluctuate with time, four fish species (herring *Clupea harengus*, cod *Gadus morhua*, redfish *Sebastes spp*. and mackerel *Scomber scombrus*) and three species of invertebrates (lobster *Homarus americanus*, northern shrimp *Pandalus borealis* and snow crab *Chionocetes opilio*) represent the main landed species in the Gulf. Landings of herring, mackerel and crab significantly increased since 2000 (Figure 4). Lobster landings are high and stable since the mid 80's. The importance of the shrimp in the landings has increased regularly since the onset of the fishery in 1966.

Certains stocks de poissons de fond se sont effondrés récemment. Les deux stocks de morues, séparées par le chenal laurentien (4T,Vn et 3Pn, 4RS) ont été sous moratoires de 1994 à 1996 et encore en 2003 et le stock de sébaste de l'Unité 1 (4RST) est sous moratoire depuis 1995. Ces événements contribuent grandement à l'analyse.

Some groundfish stocks have collapsed recently, both cod stocks, separated by the laurentian channel (4T,Vn and 3Pn, 4RS) were under moratorium from 1994 to 1996 and again in 2003 also Unit 1 redfish stock (4RST) is under moratorium since 1995. These events contribute greatly to the analysis.

Les valeurs annuelles des 14 paramètres biologiques annuels pondérés ainsi qu'une régression pour la période 1960 à 2003 sont présentées aux figures 5 à 18.

The annual weighted values for the 14 biological parameters as well as a regression over the period 1960 to 2003 are shown in figures 5 to 18.

Un sommaire des tendances décrites par les régressions linéaires de toutes les caractéristiques biologiques est présenté au tableau 4 et à la figure 19. La majorité des paramètres biologiques annuels moyens ont démontré des diminutions substantielles depuis les années soixante. La mortalité naturelle et le taux de croissance individuel (K) ne sont pas influencés par les niveaux d'exploitation. Enfin, la consommation a augmenté ce qui est cohérent avec une présence accrue d'espèces à niveau trophique bas.

A summary of the trends observed in the biological characteristics is shown in table 4 and figure 19. The majority of the annual mean biological characteristics have shown significant declines since the sixties. The exploitation levels do not influence natural mortality and the individual growth rate (K). Finally, consumption has increased, which is coherent with an increased presence species of lower trophic levels.

Comme la majorité des valeurs maximales et minimales s'observent au début et à la fin des séries respectivement, avec un certain niveau de variabilité interannuelle, les valeurs arrondies des régressions sont présentées afin de calculer des taux de déclin qui sont survenus au cours des 44 dernières années.

As the majority of maximum and minimum observations occur at the beginning and end of the series, respectively, with a certain degree of inter-annual variability, the rounded values of the regressions are presented in order to derive decline rates that occurred during these last 44 years.

Discussion

Ce type d'analyse permet de décrire les

Discussion

This type of analysis allows to describe the caractéristiques biologiques associées aux pêcheries dans le temps et de les intégrer de façon à donner une vision ou caractérisation globale de l'ensemble des débarquements du golfe du Saint-Laurent. Certaines ressources ont été grandement réduites (morue et sébaste par exemple), mais d'autres pêcheries se sont développées (cas des invertébrés) durant la période d'analyse. Ces développements ne sont pas nécessairement associés à une augmentation de la biomasse disponible mais sont plutôt liés aux intérêts économiques des marchés (crevette, pétoncle, crabe entre autres). Les tendances observées intègrent ces informations et ne sont pas seulement associées à un appauvrissement de biodiversité de l'écosystème du golfe (composante économique influençant le choix de l'espèce visée). Cette composante économique peut venir des marchés, mais aussi du coût associé à l'utilisation d'une technologie de capture. Une discrimination de l'influence de ces deux composantes est très difficile à faire.

biological characteristics of the various fisheries in time and to integrate them in order to provide visualization or a overall characterization of all landings in the Gulf of St. Lawrence. Some resources have been severely depleted (cod and redfish for example) but other fisheries have developed, not necessarily because of increasing biomass but rather due to the economic value of the markets (shrimp, scallop and crab specifically). The observed trends are thus not only associated with a reduction in biodiversity of the Gulf ecosystem because there is an economic component that drives the choice of a directed specie. Markets but also the cost of any particular harvesting technology may drive this economic component. The discrimination of the influence of these two components is very difficult to do.

Les résultats montrent qu'il y a eu des changements notables au cours des quatre dernières décennies dans le golfe du Saint Laurent. Les tendances sont à la fois le reflet de la surpêche sur certaines espèces, de l'existence de nouveaux marchés et de changements dans le réseau trophique (diminution de grandes espèces à grande longévité remplacées par des espèces plus petites et à longévité restreintes) (Piet et Jennings, 2005; Shin et *al*., 2005; Däan et *al*., 2005).

Results indicate that major shifts have occurred over the last four decades in the fisheries of the Gulf of St. Lawrence. The trends are indicative of both over fishing of certain species and changes in the trophic web (reduction of large, long living species to smaller, short lived species) (Piet and Jennings, 2005; Shin et *al*., 2005; Däan et *al*., 2005).

Il est généralement reconnu que les stock d'espèces présentes dans le Golfe (Divisions 4RST de l'OPANO) sont moins productifs qu'ailleurs et atteignent une taille maximale inférieure, ceci est particulièrement vrai pour la morue, le turbot, le flétan Atlantique et les grenadiers du Golfe (Divisions 4RST de l'OPANO) versus ceux de l'Atlantique (Divisions 2J, 3KL, 3NO de l'OPANO) (Figure 2). Certains paramètres ont également connu d'importants changements dans le temps (l'âge à la maturité chez la morue par exemple, Fréchet *et. al*. 2005). Les valeurs utilisées ici sont spécifiques à l'échelle mondiale. En plus, plusieurs valeurs ne sont pas disponibles ou pertinentes pour les invertébrés où la détermination de l'âge n'est pas toujours possible et où la croissance n'est pas continue mais par étapes via les mues. Par contre, les données de taille maximale et de niveau trophiques sont disponibles pour toutes les 53 espèces (Tableau 2). Il n'y a pas de considération pour un dimorphisme sexuel ou de rapport des sexes pour la taille maximale.

It is generally recognized that fish stocks in the Gulf (NAFO Divisions 4RST) are less productive than elsewhere and reach smaller maximum size, this is particularity evident for cod, Greenland halibut, Atlantic halibut and grenadiers which usually have a smaller maximum length in the Gulf (NAFO Divisions 4RST) than on the Atlantic shelf (NAFO Divisions 2J, 3KL; 3NO) (Figure 2). Some parameters have also shown some important changes through time (the age at maturity of cod for example, Fréchet *et al*. 2005) The values used here are taken from species specific characteristics in its worldwide distribution. Moreover, many of these are not suitable or available for invertebrates where ageing is not always feasible and where growth often is stepwise through a series of molts. However, both maximum size and trophic levels are available for the 53 species (Table 2). No consideration is given for sexual dimorphism nor is sex ratio in the maximum size.

L'impact d'un manque de données pour les invertébrés sur l'analyse devrait être limité car les débarquements en poids de ces espèces sont limités à l'exception du crabe et de la crevette qui sont aux rangs de troisième et quatrième rang

The impact of lack of data for invertebrates on the analysis should be limited because the landings in weight of these species are not significant, with the exception of crab and shrimp, which rank third and fourth, respectively, of the most important species, respectivement des espèces les plus importantes des débarquements de 2003. Comme leur caractéristiques biologiques (longévité, temps de génération, âge à maturité etc.) sont généralement au bas des gammes, les tendances pour les invertébrés sous-évaluent la situation réelle.

Une analyse similaire faite à partir des relevés de recherche serait limitée car les espèces ne sont pas toutes bien échantillonnées (chalut de fond, donc problème de représentativité).

Une amélioration de cette analyse pourrait être l'incorporation de valeurs pour les paramètres biologiques spécifiques aux espèces présentes dans le golfe, incluant à la fois les débarquements des espèces commerciales et l'échantillonnage par les relevés de recherche de l'ensemble des espèces commerciales ou non.

in the 2003 landings. Their biological characteristics (life span, generation time, age at maturity, etc) are generally in the lower end of the range, which means that the observed trends for all invertebrate species are likely to be underestimates of the actual situation.

Conducting a similar analysis on surveys would not be helpful as they do not sample adequately all commercial species because of the gear used (bottom trawl).

An improvement of this analysis could include the values of the biological parameters specific to the species encountered in the Gulf, including as well commercial samplings of these species and results from the research surveys for all commercial and non commercial species.

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Tableau 1 : Débarquements (t) des pêches dans 4RST depuis 1960. (Source : FAO)

Table 1 : Landings (t) of the fisheries from 4RST since 1960 (Source FAO)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Acipenseridae		9	21	22	14	7	6						
Alosa pseudoharengus	2091	1405	3077	3743	3599	4839	2657	2042	1762	920	2518	3577	2666
Ammodytes spp													
Anarhichas spp	15	8	54	62	169	22	57	110	200	345	525	413	318
Anguilla rostrata	98	233	306	246	330	385	369	482	581	767	830	995	802
Argentina spp													
Brosme brosme	5	9		9	1	1					4	12	15
Cancer irroratus													
Chionocetes opilio		26		108	411	249	232	617		8451	5641	5380	5449
Clupea harengus	23271	20453	36498	42221	44512	49169	43473	68722	119564	157734	180601	146137	66698
oryphaenoides rupestris													
Cyclopterus lumpus		12	10		4	4	5	4	1	16	34	1	
Gadus morhua	126091	113542	114491	105257	110720	98665	89743	93129	115672	107128	143670	116635	89976
Gadus ogac	0												
ptocephalus cynoglossus	333	3496	3387	4250	3350	3608	3712	2714	3390	4763	4805	3821	2001
oglossoides platessoides	8708	7626	5037	8470	8803	11098	12720	10497	11932	10978	13135	11770	9724
ppoglossus hippoglossus	704	780	621	537	615	693	612	460	444	510	509	454	310
Homarus americanus	14554	13146	12605	11150	10378	10558	9765	9851	10046	9499	10501	9128	8414
Illex illecebrosus	3	8	25	2	5	2							
Isurus oxyrinchus													
Lamna nasus													
Limanda ferruginea	5	15	2	107	65	53	157	79	12	268	59	40	3
Litorina		68	43	63		111	20	78	223	86	108	169	213
Lophius americanus	1												
Mallotus villosus	678	564	661	551	697	905	866	913	796	1568	456	464	537
elanogrammus aeglefinus	2236	1644	1282	1408	1185	1153	369	474	341	338	581	531	262
Menidia menidia													
Mercenaria mercenaria			133	190	208	219	107	135	161		136	114	63
Merluccius bilinearis													
Microgadus tomcod		400	549	276	301	472	496	240	308	330	393	220	316
Morone americana													
Morone saxatilis	15	14	14	3	2	6		2	6	9	11	13	9
Mya arenaria		815	889	566	675	783	873		624	616	949	1154	1244
Mytilus edulis	53	79	76		46	35	39	45	67	104	84	130	150
Osmerus mordax	1476	906	1092	1333	1789	1895	1861	1573	1642	1926	1754	1328	1190
Pandalus borealis							85	332	371	364	1071	1480	1070
Placopecten magellanicus	150	98	316	901	2033	4874	2530	4237	9381	10135	10221	6693	7476
Pollachius virens	87	19	21	54	76	21	186	30	13	143	39	35	53
Prionace glauca													
pleuronectes americanus	927	1621	2327	3165	3014	4419	3136	2454	551	1710	2694	2842	1911
hardtius hippoglossoides						24	365	365	689	802	1112	954	683
Salmo salar	650	624	711	661	858	984	936	1066	631	586	644	365	253
Salmo spp	9	9	12	9						1			
Scomber scombrus	1336	1967	1877	2764	5386	4641	5331	3203	5157	3772	5888	6054	7736
Scomberesox saurus													
Scophthalmus aquosus													
Sebastes spp	12218	10391	6585	19794	29700	48827	65215	70036	90963	88875	87588	79406	80329
Spisula polynyma													
Spisula solidissima		100	70	125	163	208		236	190	81	97	128	157
Squalus acanthias													
Thunnus thynnus										1			
Urophycis chuss				1		4778							
Urophycis tenuis	2054	5346	7271	6579	6373	2	7094	6583	4293	4267	5795	5842	5831
Total	197768	185433	200063	214627	235482	253710	253017	280709	380011	417093	482453	406285	295859

Tableau 1 (suite)
Table 1 (follow)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Acipenseridae			1		6	12	4	6	9	6	6
Alosa pseudoharengus	3744	3281	2521	2248	4455	5105	6841	7099	4624	3790	2717
Ammodytes spp											
Anarhichas spp	289	342	259	208	322	157	212	344	390	415	742
Anguilla rostrata	626	533	628	500	644	598	590	778	848	591	497
Argentina spp											
Brosme brosme		23		1	6	6	2	8	5	9	
Cancer irroratus			26	84	137	228	6	141	145	122	456
Chionocetes opilio	7424	7238	4612	7053	9344	12451	17768	18212	23242	34018	29943
Clupea harengus	68104	42386	49725	51155	57884	68796	66551	60458	35448	35317	35674
Coryphaenoides rupestris											
Cyclopterus lumpus	8	3	2	17	13	6	8	4	3	2	
Gadus morhua	80261	81003	82853	86116	85537	97157	118556	124937	130913	132872	138195
Gadus ogac											
Glyptocephalus cynoglossus	2224	3247	2722	6875	3039	4510	4561	3527	1912	1282	1177
Hippoglossoides platessoides	8007	11261	10177	14265	12665	12375	12943	11115	10210	8092	8382
Hippoglossus hippoglossus	385	418	272	196	150	135	132	202	95	91	174
Homarus americanus	8302	7207	9616	9618	10336	12419	13706	13157	13772	14372	17290
Illex illecebrosus	3		3	65	37	118	769	112	84	211	5
Isurus oxyrinchus											
Lamna nasus									1		9
Limanda ferruginea	6	27	3	37	30	13	69	46	14	6	50
Litorina	173	276	229	486	334	345	335	286	265	306	37
Lophius americanus		1	2						1		2
Mallotus villosus	429	421	267	476	1901	9701	9032	3520	2402	393	1024
Melanogrammus aeglefinus	300	267	177	143	140	158	268	345	386	485	252
Menidia menidia			69	99	153	209	319	60	33	67	107
Mercenaria mercenaria	40	176	189	47	148	53	62	68	189	533	519
Merluccius bilinearis						6	3		1		
Microgadus tomcod	426	269	204	282	340	304	346	218	276	173	148
Morone americana											
Morone saxatilis	6	5	7	7	5	5	7	15	48	32	23
Mya arenaria	796	854	885	1021	1126	1071	1085	876	708	534	392
Mytilus edulis	134	23	97	80	71	111	39	188	135	184	223
Osmerus mordax	1474	1834	1798	2070	1896	2189	2516	2262	2118	2426	1058
Pandalus borealis	2142	3547	4683	4934	5146	6538	7830	7619	8458	8587	9077
Placopecten magellanicus	4996	2379	3370	4202	2254	2364	3312	3867	5632	3051	4450
Pollachius virens	13	66	16	13	72	54	146	114	180	37	93
Prionace glauca											
Pseudopleuronectes americanus	2384	1976	2050	2471	1358	1236	1722	2053	2013	2339	1799
Reinhardtius hippoglossoides	763	1011	1544	2019	3961	6247	8791	7006	3176	2269	1105
Salmo salar	293	351	283	334	380	220	188	396	332	251	264
Salmo spp							1	8	9		5
Scomber scombrus	9936	7023	2217	3155	2763	3261	6583	9093	6026	8505	6665
Scomberesox saurus											
Scophthalmus aquosus											
Sebastes spp	130164	63489	65401	37983	15840	13591	15034	14832	20549	26456	24505
Spisula polynyma											
Spisula solidissima	118	161	116	159	94	187	344	292	337	379	504
Squalus acanthias			3								
Thunnus thynnus	57	373	237	320	263	197	204	323	265	203	380
Urophycis chuss											
Urophycis tenuis	5816	3761	4245	4006	4241	5078	8351	12739	14207	10230	7370
Total	339843	245232	251509	242745	227091	267211	309236	306326	289461	298636	295319

Tableau 1 (suite)
Table 1 (follow)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Acipenseridae	6	23	5	32	20	60	126	146	237	164	206
Alosa pseudoharengus	1923	5834	3779	6087	6822	5933	4773	4743	4536	4721	3943
Ammodytes spp										3	1
Anarhichas spp	505	302	388	250	131	138	173	158	119	107	8
Anguilla rostrata	408	455	496	735	729	719	772	795	588	601	457
Argentina spp										7	25
Brosme brosme			1	1							
Cancer irroratus	600	590	500	1520	1663	1309	860	1084	959	2141	4145
Chionocetes opilio	33036	35476	33347	19988	19445	13450	13972	17602	19254	23252	31541
Clupea harengus	34014	47252	73574	95839	90860	77153	94953	75044	69629	64257	97196
Coryphaenoides rupestris											
Cyclopterus lumpus		1	4	2	179		3	2	12	7	3
Gadus morhua	128354	121659	108672	91761	83510	83114	75328	59114	48877	19365	1528
Gadus ogac				16	2			2	5	1	2
Glyptocephalus cynoglossus	1107	1660	1823	2609	2530	2347	1287	1000	993	897	445
Hippoglossoides platessoides	11790	11324	9581	10409	8980	7520	6294	6592	6405	2700	2654
Hippoglossus hippoglossus	176	151	314	261	238	291	450	361	142	128	177
Homarus americanus	16837	19436	21699	22958	23866	26388	26885	26448	24898	24296	22499
Illex illecebrosus	1			4	34	38	10	6	5	33	37
Isurus oxyrinchus											
Lamna nasus						9		165	228	147	76
Limanda ferruginea	82	255	418	409	215	55	62	83	120	92	64
Litorina		71		1			429	874	890	737	570
Lophius americanus			4	12	4	29	21	31	24	30	72
Mallotus villosus	2087	3062	3745	974	5092	10034	6522	7472	9517	10925	931
Melanogrammus aeglefinus	237	932	898	715	569	233	100	30	20	12	1
Menidia menidia	200	47	75	137	80	33	82	118	46	83	543
Mercenaria mercenaria		563	594	745	754	662	972	1043	859	800	639
Merluccius bilinearis	10									6	1
Microgadus tomcod	25	179	259	137	27	33	12	48	36	70	69
Morone americana										4	
Morone saxatilis	12	19	10	2	3	4	1	1	9	2	1
Mya arenaria	465	2256	2383	1754	1299	1259	1466	1156	1336	1090	1341
Mytilus edulis	366	588	1474	1214	1131	2874	2871	3598	4297	4903	6085
Osmerus mordax	988	833	2319	1721	1691	1423	1062	1204	1071	1115	1374
Pandalus borealis	8090	8819	9470	12135	13896	15570	15817	16297	12875	15479	16557
Placopecten magellanicus	4921	5945	5273	4983	3920	5354	6346	4966	6031	7344	5369
Pollachius virens	109	116	809	1289	345	566	164	62	46	55	47
Prionace glauca											
Pseudopleuronectes americanus	178	1920	3845	2808	1847	2695	2354	2859	2194	1573	1292
Reinhardtius hippoglossoides	2126	2349	6537	11069	7583	5049	2448	2265	3441	2776	3641
Salmo salar	114	151	175	306	259	187	154	115	93	66	50
Salmo spp	7	17	2	5	4	5	59	74	6	12	2
Scomber scombrus	5846	7960	13271	12349	13346	13392	12103	17694	13891	14822	12930
Scomberesox saurus				1							
Scophthalmus aquosus											
Sebastes spp	34811	28067	33593	34311	38826	44734	50129	51162	49539	25332	10287
Spisula polynyma								46	213	78	639
Spisula solidissima	1823	936	534	689	434	516	1216	747	1127	932	921
Squalus acanthias							550				8
Thunnus thynnus	237	106	35	27	54	84	9	53	14	112	63
Urophycis chuss											
Urophycis tenuis	7168	6114	5178	6562	3994	5463	5257	4652	4094	1676	1159
Total	298659	315468	345084	346827	334382	328723	336092	309912	288676	232953	229599

Tableau 1 (suite)
Table 1 (follow)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total
Acipenseridae	156	75	83	64	11	2	4		1549	3 098
Alosa pseudoharengus	3468	2386	3024	4284	4048	2443	2470	4952	3088	164 578
Ammodytes spp		2	1			2				9
Anarhichas spp	13	14	73	52	81	97	94	97	15	8 793
Anguilla rostrata	359	313	233	285	169	151	167	197	37	21 923
Argentina spp					1					33
Brosme brosme										118
Cancer irroratus	5144	3929	6039	5826	4556	6479	6726	7048	6198	68 661
Chionocetes opilio	32331	26997	24771	21296	23963	29622	29525	38152	28943	713 832
Clupea harengus	105682	90580	75794	77564	83673	89584	81032	74352	82115	3 150 698
Coryphaenoides rupestris		2								2
Cyclopterus lumpus	2	3	68	5	1	2			30	481
Gadus morhua	1199	1344	4514	5104	11907	11290	11059	9893	581	3 461 292
Gadus ogac	2	3	15	30	3	1				82
Glyptocephalus cynoglossus	328	500	570	870	734	995	822	1004	655	101 882
Hippoglossoides platessoides	2502	1617	2011	1574	1953	1745	1381	806	540	348 368
Hippoglossus hippoglossus	99	226	289	312	264	312	313	317	306	14 626
Homarus americanus	22769	22087	20689	21831	21191	21783	21216	20859	20843	718 868
Illex illecebrosus	68	16	8	5	4		1		3	1 725
Isurus oxyrinchus					7	10		1		18
Lamna nasus	28	20	73	51	15	18	1	12	3	856
Limanda ferruginea	204	210	812	215	309	295	317	216	158	5 757
Litorina	942	1114	1014	844	1454	1571	1573	1590	1993	19 921
Lophius americanus	6	3	1	4	15	19	14	15	20	331
Mallotus villosus	151	6908	7968	9106	4929	5122	741	3301	5032	142 841
Melanogrammus aeglefinus						1	5	3	2	18 483
Menidia menidia	223	151	238	231	558	304	646	135	269	5 315
Mercenaria mercenaria	614	699	725	775	865	1022	979	752		17 552
Merluccius bilinearis									1	28
Microgadus tomcod	108	117	65	93	39	31	10	1		8 646
Morone americana										4
Morone saxatilis	17	15								360
Mya arenaria	1804	1112	1772	2204	1878	2095	1507	1504	1210	49 427
Mytilus edulis	4414	8150	9162	10272	12076	14432	11500	13707	155	115 462
Osmerus mordax	1086	906	1220	1239	974	955	182	308	284	63 361
Pandalus borealis	17031	18420	20351	23511	23638	26364	24862	29164	27616	429 296
Placopecten magellanicus	6734	7200	5625	3251	1706	1841	1178		882	187 791
Pollachius virens			6	1	10	6	2		3	5 217
Prionace glauca					1	1				2
Pseudopleuronectes americanus	753	894	1173	660	669	662	606	481	483	82 118
Reinhardtius hippoglossoides	2436	1976	2625	3936	3524	2183	1282	1655	3623	115 410
Salmo salar	44	37	29	7	1					14 049
Salmo spp	2									258
Scomber scombrus	11030	15158	16501	14875	12862	10321	18922	33865	39022	430 499
Scomberesox saurus										1
Scophthalmus aquosus					54	85	39	39	38	255
Sebastes spp	50	71	31	389	1109	1105	1086	1205	836	1 524 444
Spisula polynyma	248	212	214	302	263	445	400	511	877	4 448
Spisula solidissima	525	506	796	444	399	461	415	599	423	18 689
Squalus acanthias						148	115		21	845
Thunnus thynnus	176	111	104	117	164	241			192	4 722
Urophycis chuss										4 779
Urophycis tenuis	77	177	199	247	416	321	233	79	51	200 491
Total	222825	214261	208886	211876	220494	234567	221425	246820	228097	12250745

Tableau 2: Caractéristiques biologiques (Source poissons = www.fishbase.org, Invertébrés = www.seaaroundus.org).

Table 2: Biological characteristics (Sources Fish = www.fishbase.org, Invertebrates = www.seaaroundus.org).

Latin	Français *French*	Anglais *English*	Niveau trophique *Trophic level*	Taille maximum *Maximum length* (Lmax) cm	Age à la première maturité *Age at first maturity* (temps) an *(tm) year*	Longévité *Longevity* (aprox.) an *(approx.) year*	Temps de génération *Generation time* année *year*	Taux de croissance *Growth rate* /an */year*	Taux intrinsect de croissance *Intrinsic growth rate* (rm)/an *(rm)/year*
Acipenser oxyrinchus	Esturgeon noir	Atlantic sturgeon	3.4	403	7.8	41.5	14.5	0.07	0.36
Alosa pseudoharengus	Gaspareau	Alewife	3.5	40	1.1	4.1	1.6	0.69	4.38
Ammodytes americanus	Lançon d'Amérique	American sand lance	3.2	22	1.6	5.9	2.2	0.48	2.26
Anarhichas lupus	Loup atlantique	Atlantic wolffish	3.2	150	14.6	65.6	22.9	0.04	0.20
Anguilla rostrata	Anguille d'Amérique	American ell	3.7	152	4.0	19.4	6.5	0.15	0.68
Argentina silus	Grande argentine	Atlantic argentine	3.3	70	5.6	23.6	7.7	0.12	0.58
Brosme brosme	Brosme	Cusk	4.0	120	4.5	21.3	7.2	0.14	0.60
Cancer iroratus	Crabe commun	rock crab	2.6	12					
Chionocetes opilio	Crabe des neiges	Snow crab	2.3	20					
Clupea harengus	Hareng atlantique	Atlantic herring	3.2	45	2.5	9.8	3.1	0.29	1.42
Coryphaenoides rupestris	Grenadier de roche	Rock grenadier	3.5	110	6.2	28.4	9.2	0.10	0.50
Cyclopterus lumpus	Grosse poule de mer	Lumpfish	3.9	60	5.5	23.8	7.8	0.12	0.58
Gadus morhua	Morue franche	Atlantic cod	4.4	200	3.1	15.2	6.0	0.19	0.66
Gadus ogac	Ogac	Greenland cod	3.6	77	4.1	18.1	5.7	0.16	0.56
Glyptocephalus cynoglossus	Plie grise	Witch flounder	3.1	60	3.4	14.2	4.8	0.20	0.90
Hippoglossoides platessoides	Plie	American plaice	3.6	82	5.9	26.5	9.3	0.11	0.46
Hippoglossus hippoglossus	Flétan atlantique	Atlantic halibut	4.5	240	17.7	96.8	35.7	0.03	0.12
Homarus americanus	Homard	Lobster	2.6	64					
Illex illecebrosus	Encornet rouge boréale	Northern shortfin squid	3.2	31					
Isurus oxyrinchus	Mako à nageoires courtes	Shortfin mako	4.5	200	2.6	14.4	5.7	0.20	0.70
Lamna nasus	Requin-taupe commun	Porbeagle	4.5	350	8.8	47.7	18.0	0.06	0.24
Limanda ferruginea	Limande à queue jaune	Yelowtail flounder	3.2	64	2.0	8.5	3.0	0.34	1.38
Littorea littorina	Bigorneau	Periwinkle	2.0	2					
Lophius americanus	Beaudroie d'Amérique	Monkfish	4.5	120	5.8	29.8	10.6	0.10	0.42
Mallotus villosus	Capelan	Capelin	3.1	20	1.7	6.2	2.1	0.45	1.88
Melanogrammus aeglefinus	Aiglefin	Haddock	4.1	100	5.1	25.0	9.4	0.12	0.42
Menidia menidia	Capucette	Atlantic silverside	3.2	15	0.8	2.6	0.8	1.09	4.92
Mercenaria mercenaria	Praire d'Amérique	Hard-shell clam	2.0	14					
Merluccius bilinearis	Merlu argenté	Silver hake	4.3	76	1.9	8.0	2.8	0.36	1.52
Microgadus tomcod	Poulamon atlantique	Atlantic tomcod	3.3	38	2.7	10.9	3.1	0.26	1.26
Morone americana	Bar-perche	White perch	3.0	49	9.6	39.0	11.5	0.07	0.66
Morone saxatilis	Bar rayé	Stripped bass	4.5	200	11.2	57.9	19.8	0.05	0.30
Mya arenaria	Mye commune	Soft-shell clam	2.0	9					
Mytilus edulis	Moule bleue	Blue mussel	2.0	9					
Osmerus mordax mordax	Éperlan arc-en-ciel	Rainbow smelt	3.0	35	1.4	5.5	2.1	0.52	1.74
Pandalus boréalis	Crevette nordique	Northern shrimp	2.5	14					
Placopecten magellanicus	Pétoncle géant	Atlantic deep-sea scallop	2.0	20					
Pollachius virens	Goberge	Pollock	4.4	130	3.6	16.9	6.0	0.17	0.72
Prionace glauca	Requin bleu	Blue shark	4.2	400	3.3	18.2	7.8	0.16	0.48
Pseudopleuronectes americanus	Plie rouge	Winter flounder	2.8	64	1.0	4.1	1.5	0.69	2.60
Reinhardtius hippoglossoides	Flétan du Groenland	Greenland halibut	4.5	80	6.0	28.8	10.4	0.10	0.40
Salmo salar	Saumon atlantique	Atlantic salmon	4.4	150	2.0	10.0	4.3	0.29	0.84
Salmo trutta	Truite brune	Brown trout	3.2	140	3.8	18.3	6.5	0.16	0.66
Scomber scombrus	Maquereau bleu	Atlantic mackerel	3.6	60	2.5	10.6	3.5	0.27	1.20
Scomberesox saurus saurus	Balaou	Atlantic saury	3.6	50	2.0	8.7	2.6	0.33	1.66
Scophthalmus aquosus	Turbot de sable	Windowpane	3.6	45	2.9	11.8	3.7	0.24	1.30
Sebastes mentela	Sébaste atlantique	Deepwater redfish	3.6	55	9.7	39.0	11.4	0.07	0.46
Spisula polynyma	Douceron de Stimpson	Stimpson's surf clam	2.0	14					
Spisula solidissima	Mactre solide	Atlantic surf clam	2.0	17					
Squalus acanthias	Aiguillat commun	Spiny dogfish	4.3	160	14.1	80.1	26.5	0.04	0.24
Thunnus thynnus	Thon rouge	Bluefin tuna	4.4	458	7.5	41.0	14.9	0.07	0.32
Urophycis chuss	Merluche-écureuil	Red hake	3.6	66	3.5	15.1	4.6	0.19	1.06
Urophycis tenuis	Merluche blanche	White hake	4.2	133	5.3	27.2	10.0	0.11	0.40

Tableau 2: (Suite).

Table 2: (Follow).

Latin	Français French	Anglais English	Longueur au rendement max *Length at maximum yield* (Lopt) cm	Rendement par recrue relatif *Relative yield per recruit* (Y'/R)	Mortalité naturelle *Natural mortality* (M)/an *(M)/year*	Fécondité *Fecundity*	Consommation *Consumption*	Azone et protéine *Nitrogen & protein* (g)	Résiliance *Resiliance*
Acipenser oxyrinchus	Esturgeon noir	Atlantic sturgeon	172.0	0.041	0.11	1 966 829	1.4	518 929	2
Alosa pseudoharengus	Gaspareau	Alewife	10.7	0.032	1.29	37 932	8.6	44	4
Ammodytes americanus	Lançon d'Amérique	American sand lance	14.1	0.044	0.72		6.2	48	4
Anarhichas lupus	Loup atlantique	Atlantic wolffish	111.3	0.044	0.06		1.0	54 573	1
Anguilla rostrata	Anguille d'Amérique	American ell	102.1	0.046	0.22		3.1	9 065	2
Argentina silus	Grande argentine	Atlantic argentine	34.4	0.041	0.19		10.2	1 246	2
Brosme brosme	Brosme	Cusk	57.1	0.047	0.20	2 449 490	2.2	26	2
Cancer irroratus	Crabe commun	rock crab					2.6		
Chionocetes opilio	Crabe des neiges	Snow crab					2.3		
Clupea harengus	Hareng atlantique	Atlantic herring	21.9	0.042	0.45	31 623	10.1	308	3
Coryphaenoides rupestris	Grenadier de roche	Rock grenadier	57.5	0.040	0.16	23 467	1.3	79 799	2
Cyclopterus lumpus	Grosse poule de mer	Lumpfish	36.0	0.041	0.19	187 083	1.6	7 679	2
Gadus morhua	Morue franche	Atlantic cod	91.9	0.060	0.23	2 133 073	2.6	22 326	3
Gadus ogac	Ogac	Greenland cod	50.8	0.061	0.19		1.4	5 879	3
Glyptocephalus cynoglossus	Plie grise	Witch flounder	29.1	0.044	0.30		3.0	619	3
Hippoglossoides platessoides	Plie	American plaice	44.1	0.051	0.15	387 298	1.9	1 249	2
Hippoglossus hippoglossus	Flétan atlantique	Atlantic halibut	209.8	0.052	0.04	2 133 073	0.5	1 508 801	1
Homarus americanus	Homard	Lobster							
Illex illecebrosus	Encornet rouge boréale	Northern shortfin squid							
Isurus oxyrinchus	Mako à nageoires courtes	Shortfin mako	263.6	0.057	0.25	8	9.6	357 613	3
Lamna nasus	Requin-taupe commun	Porbeagle	241.6	0.052	0.08	2	1.0	306 810	2
Limanda ferruginea	Limande à queue jaune	Yelowtail flounder	34.5	0.051	0.46		3.2	16 666	4
Littorea littorina	Bigorneau	Periwinkle							
Lophius americanus	Beaudroie d'Amérique	Monkfish	99.5	0.049	0.14	915 089	1.4	52 906	2
Mallotus villosus	Capelan	Capelin	13.5	0.049	0.63	8 485	4.5	40	4
Melanogrammus aeglefinus	Aiglefin	Haddock	68.3	0.057	0.15	318 206	5.0	9 365	2
Menidia menidia	Capucette	Atlantic silverside	9.1	0.044	1.64		9.3	16	4
Mercenaria mercenaria	Praire d'Amérique	Hard-shell clam							
Merluccius bilinearis	Merlu argenté	Silver hake	33.6	0.048	0.51		4.3	883	4
Microgadus tomcod	Poulamon atlantique	Atlantic tomcod	24.7	0.043	0.40		3.7	625	3
Morone americana	Bar-perche	White perch	32.7	0.022	0.16		3.7	2 170	2
Morone saxatilis	Bar rayé	Stripped bass	135.3	0.034	0.09	250 998	2.3	115 761	1
Mya arenaria	Mye commune	Soft-shell clam							
Mytilus edulis	Moule bleue	Blue mussel							
Osmerus mordax mordax	Éperlan arc-en-ciel	Rainbow smelt	18.3	0.062	0.61	24 323	2.9	142	4
Pandalus boréalis	Crevette nordique	Northern shrimp							
Placopecten magellanicus	Pétoncle géant	Atlantic deep-sea scallop							
Pollachius virens	Goberge	Pollock	72.1	0.048	0.24	1 348 036	4.8	11 579	3
Prionace glauca	Requin bleu	Blue shark	253.3	0.071	0.17	23	1.0	620 706	3
Pseudopleuronectes americanus	Plie rouge	Winter flounder	31.7	0.054	0.90		4.4	16 666	4
Reinhardtius hippoglossoides	Flétan du Groenland	Greenland halibut	76.4	0.049	0.14	45 166	1.4	16 666	2
Salmo salar	Saumon atlantique	Atlantic salmon	116.0	0.073	0.30	14 422	7.1	34 927	3
Salmo trutta	Truite brune	Brown trout	67.7	0.050	0.22	7 071	11.7	10 577	3
Scomber scombrus	Maquereau bleu	Atlantic mackerel	29.8	0.045	0.40	629 285	4.4	743	3
Scomberesox saurus saurus	Balaou	Atlantic saury	32.7	0.040	0.53		5.7	452	4
Scophthalmus aquosus	Turbot de sable	Windowpane	26.4	0.038	0.40		4.0	526	3
Sebastes mentela	Sébaste atlantique	Deepwater redfish	30.8	0.032	0.13	10 247	2.5	923	2
Spisula polynyma	Douceron de Stimpson	Stimpson's surf clam							
Spisula solidissima	Mactre solide	Atlantic surf clam							
Squalus acanthias	Aiguillat commun	Spiny dogfish	100.6	0.035	0.07	4	4.8	12 436	1
Thunnus thynnus	Thon rouge	Bluefin tuna	253.8	0.047	0.10		3.9	785 784	2
Urophycis chuss	Merluche-écureuil	Red hake	38.6	0.037	0.32		3.7	13 067	3
Urophycis tenuis	Merluche blanche	White hake	95.5	0.056	0.14	3 872 983	3.1	23 194	2

Tableau 3: Corellations parmis les paramètres biologiques.

Table 3 : Corellations between biological parameters.

	Taille maximum *Maximum length*	Age à la première maturité *Age at first maturity*	Longévité *Longevity*	Temps de génération *Generation time*	Taux de croissance *Growth rate*	Taux intrinsect de croissance *Intrinsic growth rate*	Longueur au rendement maximum *Length at maximum yield*	Rendement par recrue relatif *Relative yield per recruit*	Mortalité naturelle *Natural mortality*	Fécondité *Fecundity*	Consommation *Consumption*	Azone et protéine *Nitrogen & protein*	Résiliance *Resiliance*
Niveau trophique *Trophic level*	0.62	0.31	0.39	0.44	-0.46	-0.46	0.64	0.30	-0.46	0.30	-0.17	0.38	-0.43
Taille maximum *Maximum length*		0.40	0.47	0.52	-0.45	-0.47	0.91	0.29	-0.47	0.07	-0.26	0.69	-0.42
Age à la première maturité *Age at first maturity*			0.99	0.97	-0.64	-0.58	0.43	-0.28	-0.60	0.12	-0.43	0.16	-0.87
Longévité *Longevity*				0.99	-0.62	-0.57	0.51	0.54	-0.59	0.13	-0.42	0.57	-0.85
Temps de génération *Generation time*					-0.61	-0.57	0.57	-0.13	-0.58	0.16	-0.42	0.63	-0.84
Taux de croissance *Growth rate*						0.96	-0.45	0.05	0.98	-0.21	0.46	-0.27	0.79
Taux intrinsect de croissance *Intrinsic growth rate*							-0.49	-0.14	1.00	-0.23	0.48	-0.28	0.73
Longueur au rendement maximum *Length at maximum yield*								0.37	-0.48	0.02	-0.23	0.10	-0.44
Rendement par recrue relatif *Relative yield per recruit*									-0.09	0.13	-0.08	0.21	0.21
Mortalité naturelle *Natural mortality*										-0.22	0.48	-0.28	0.75
Fécondité *Fecundity*											-0.25	0.18	-0.25
Consommation *Consumption*												-0.26	0.42
Azone et protéine *Nitrogen & protein*													-0.33

Tableau 4: Sommaire des changements observés dans les caractéristiques biologiques des espèces débarquées dans le golfe (1960 à 2003).

Table 4: Summary of the observed changes in biological parameters of the species landed in the Gulf (1960 to 2003).

Paramètre	*Parameter*	Unité *Unit*	1960	2003	Changement *Change* (%)
Niveau trophique	*Trophic level*		4	3	-0.25
Taille maximum	*Maximum size*	cm	140	50	-0.64
Âge à maturité	*Age at maturity*	an - *year*	4.8	2	-0.58
Longévité	*Longevity*	an - *year*	20	7	-0.65
Temps de génération	*Generation time*	an - *year*	7.0	2.5	-0.64
Croissance	*Growth*	K	0.190	0.165	-0.13
Taux de croissance	*Growth rate*	rm	0.8	0.8	0.00
Longueur au rendement max.	*Length at max. yield*	cm	65	20	-0.69
Rendement par recrue	*Yield per recruit*	Y/R	0.050	0.025	-0.50
Mortalité naturelle	*Natural mortality*	M	0.265	0.255	-0.04
Fécondité	*Fecundity*	Œufs - *eggs*	1 300 000	200 000	-0.85
Consommation 1	*Consumption 1*		4.0	4.4	0.10
Azote et protéines 2	*Nitrogen and protein 2*		16 000	4 000	-0.75
Résiliance 3	*Resiliance 3*		2.8	1.8	-0.36

1 = Function de Q, B et W inf.

1 = Function of Q, B and W inf.

2 = Protéines = 6.35* log(N) = 1.3 * (log(gr)) - 1.65

2 = Protein = 6.35 log(N) = 1.3 * (log(gr)) - 1.65*

3 = Function de K, fécondité, tm et tmax.

3 = Function of K, fecundity, tm and tmax.

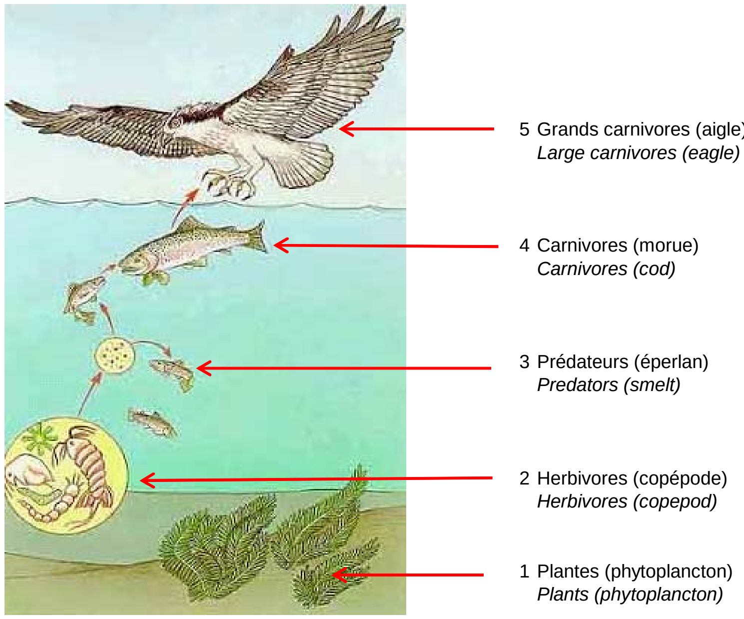

Figure 1 : Exemple de niveaux trophiques (Source : Energetics in Ecosystems)
Figure 1 : Example of trophic levels (Source : Energetics in Ecosystems)

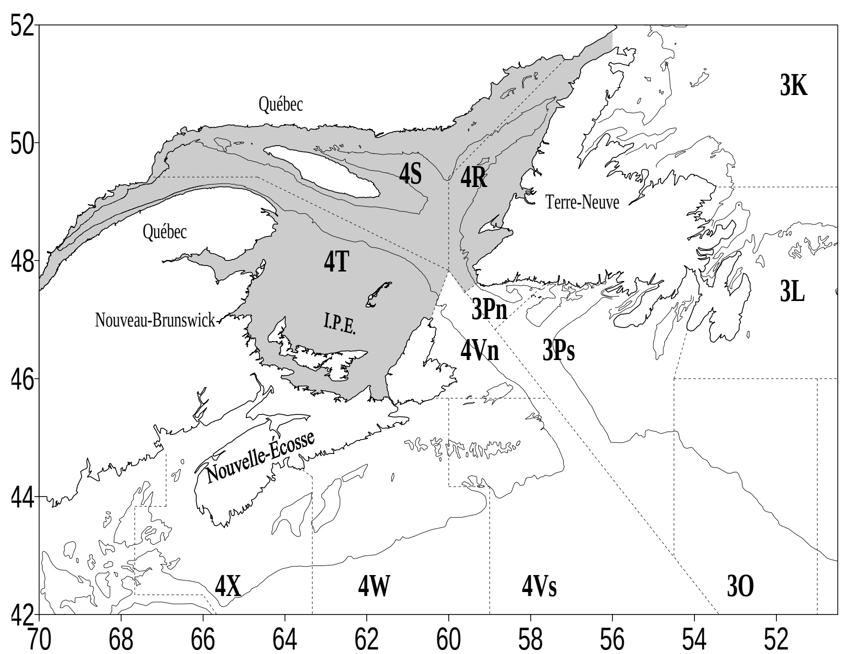

Figure 2 : Carte des Divisions 4RST de l'OPANO.
Figure 2 : Map of NAFO Divisions 4RST.

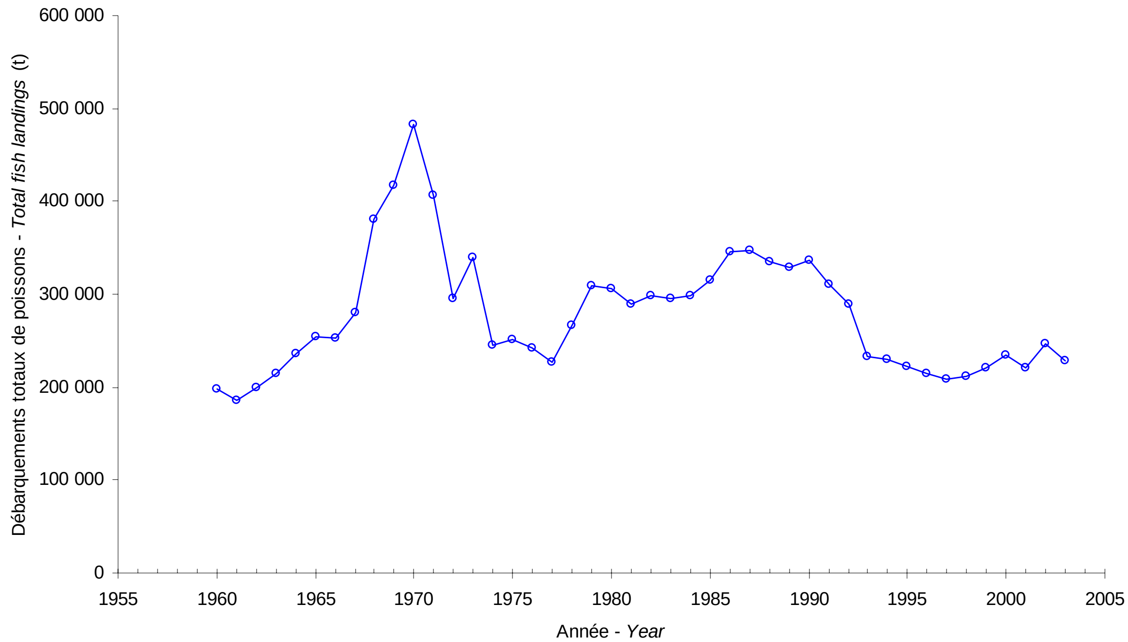

Figure 3 : Somme des débarquements commerciaux du Golfe du Saint-Laurent (4RST).
Figure 3 : Sum of the commercial landings of the Gulf of St.Lawrence

A)

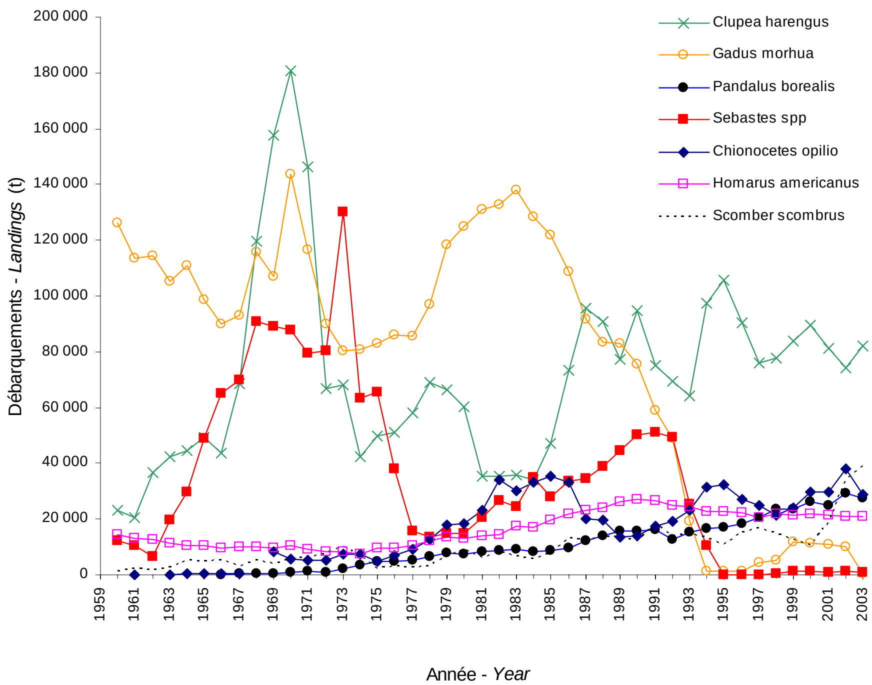

Figure 4: Débarquements des principales espèces pêchées dans le golfe du Saint-Laurent.
Figure 4 : Landings of the main species caught in the gulf of St.Lawrence.

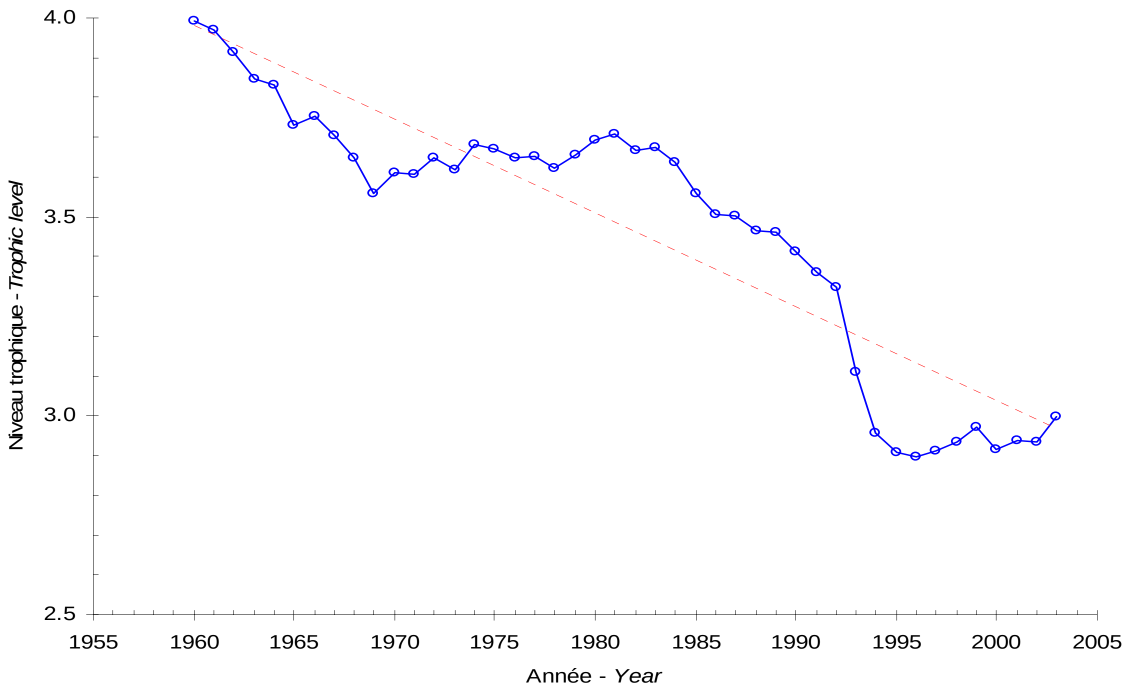

Figure 5 : Tendance des niveaux trophiques moyens pondérés des pêches du golfe du Saint-Laurent.
Figure 5 : Overall trend in the weighted average trophic level of the Gulf of St. Lawrence fisheries.

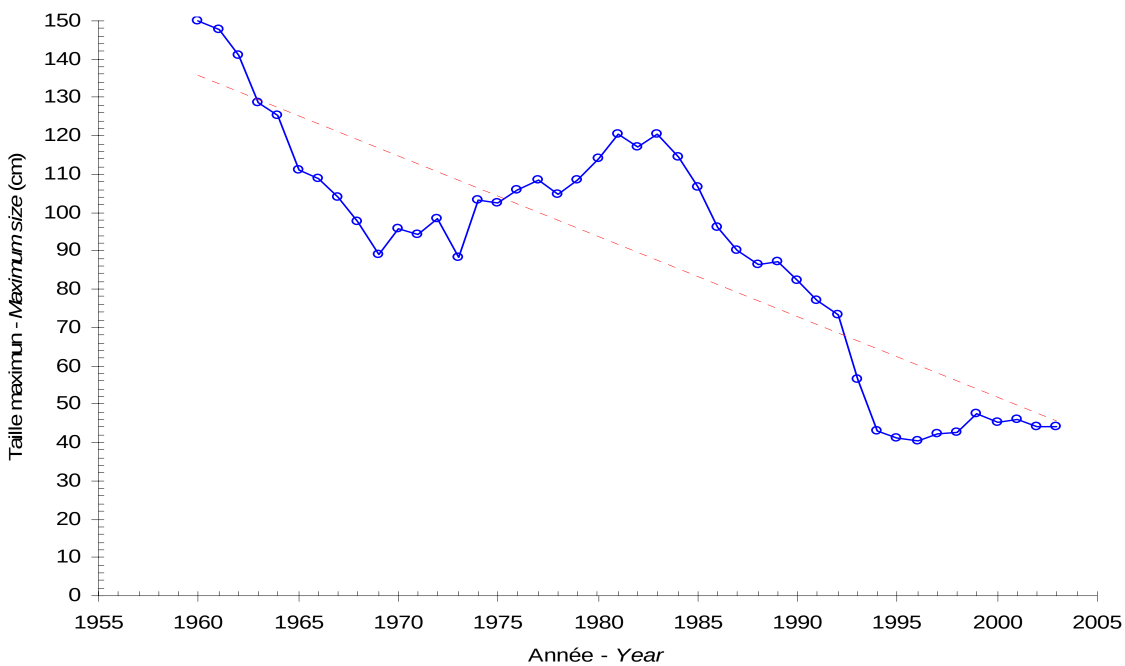

Figure 6 : Tendance des tailles maximales moyennes pondérées des pêches du golfe du Saint-Laurent.
Figure 6 : Overall trend in the weighted average maximum size of the Gulf of St. Lawrence fisheries.

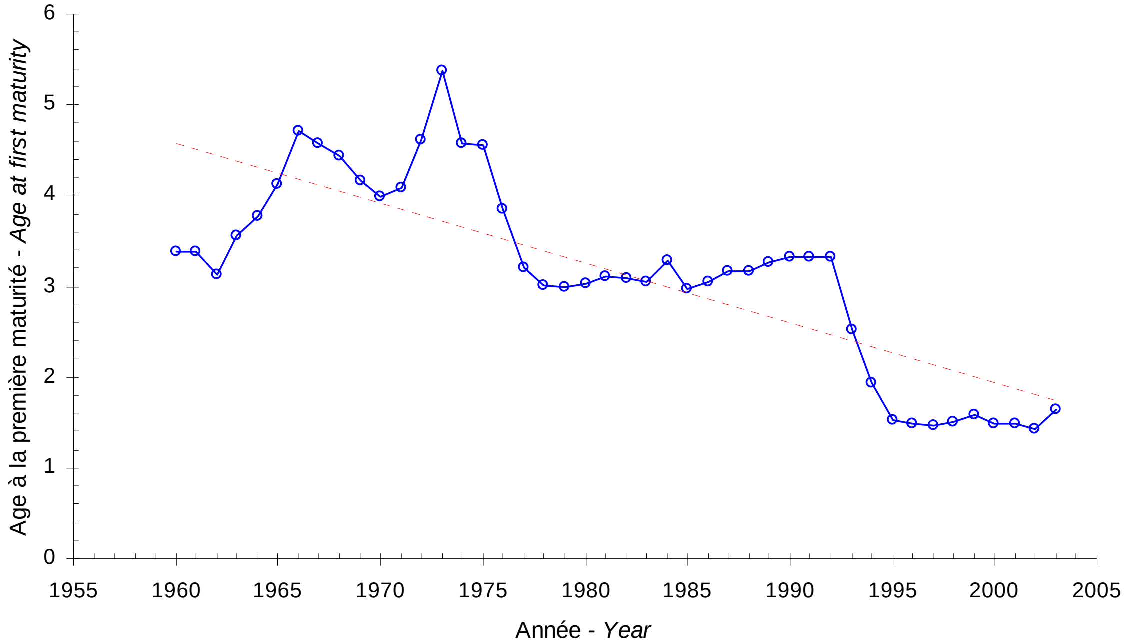

Figure 7 : Tendance générale de l'âge à la première maturité moyenne pondérée des pêches du golfe du Saint-Laurent.
Figure 7 : Overall trend in the weighted age of first maturity of the Gulf of St. Lawrence fisheries.

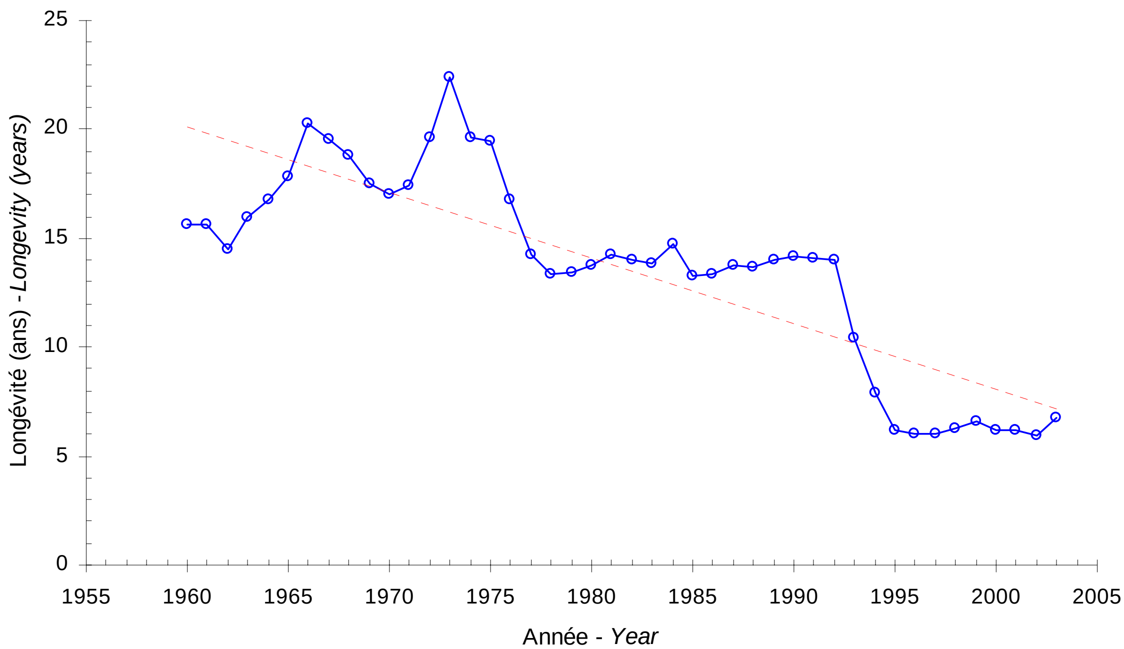

Figure 8 : Tendance générale de la longévité moyenne pondérée des pêches du golfe du Saint-Laurent.
Figure 8 : Overall trend in the weighted age of longevity of the Gulf of St. Lawrence fisheries.

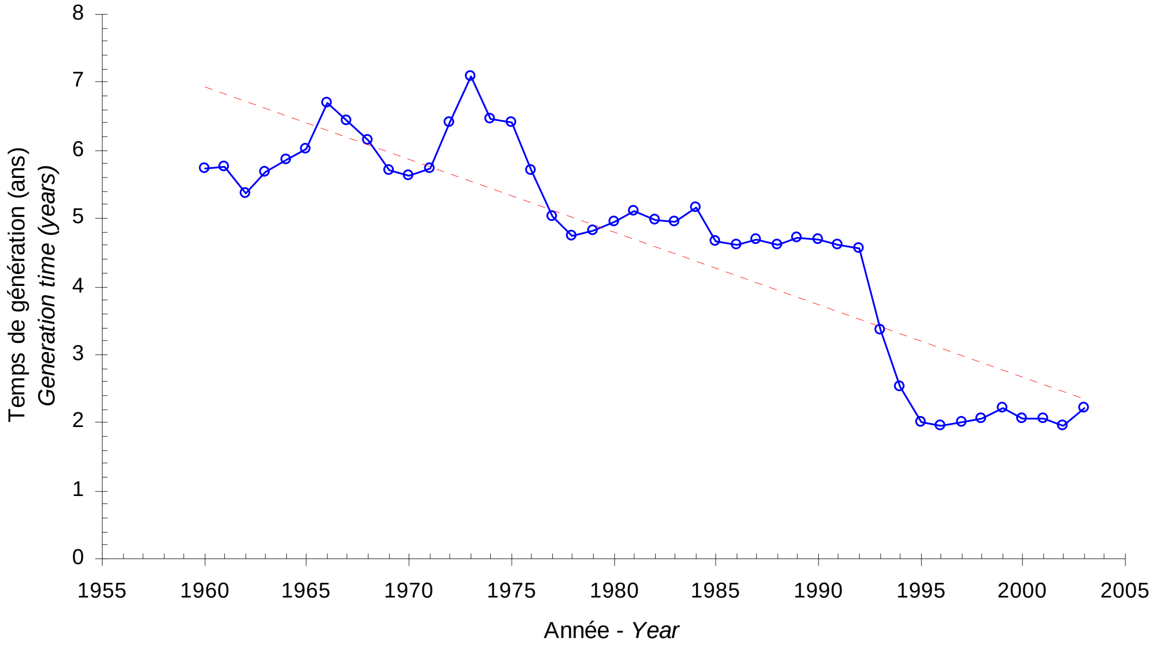

Figure 9 : Tendance générale du temps de génération moyen pondéré des pêches du golfe du Saint-Laurent.
Figure 9 : Overall trend in the weighted time of a generation of the Gulf of St. Lawrence fisheries.

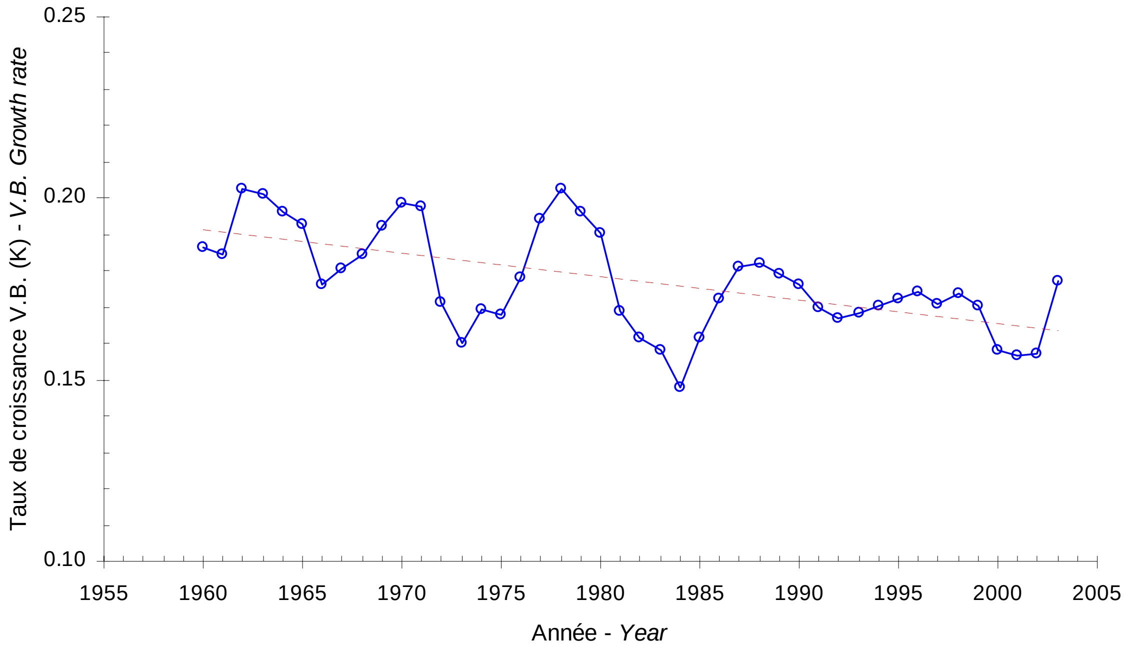

Figure 10 : Tendance générale du paramètre de croissance K de Von Bertalanffy moyen pondéré des pêches du golfe du Saint-Laurent.
Figure 10 : Overall trend in the weighted Von Bertalanffy growth parameter (K) of the Gulf of St. Lawrence fisheries.

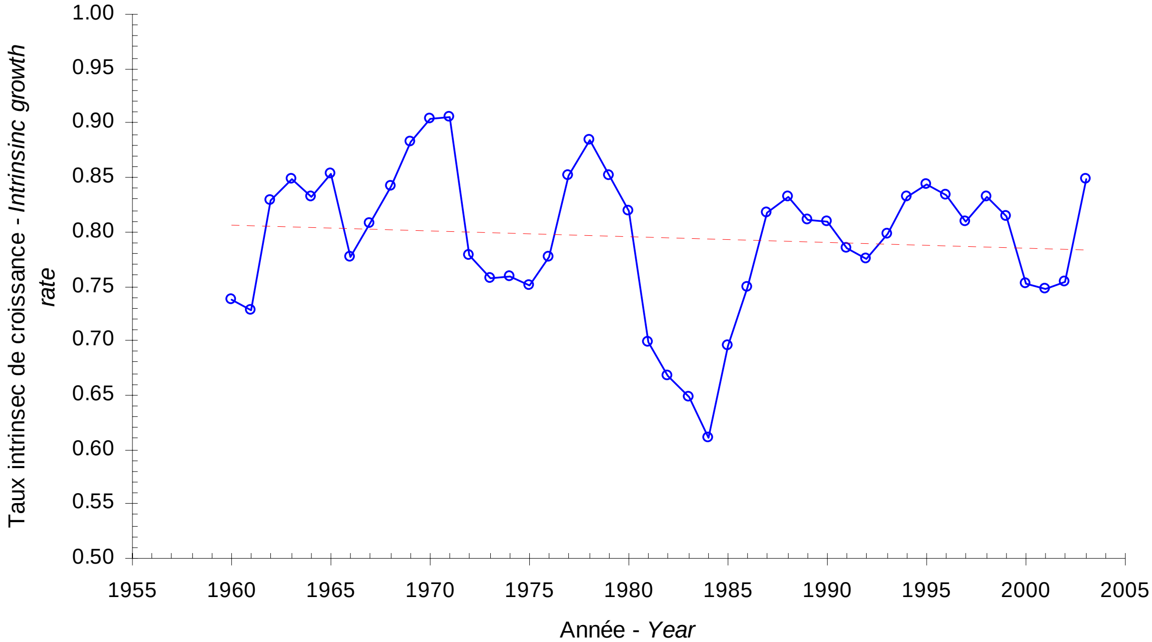

Figure 11 : Tendance générale du taux de croissance de population moyen pondéré des pêches du golfe du Saint-Laurent.
Figure 11 : Overall trend in the weighted intrinsic rate of population increase of the Gulf of St. Lawrence fisheries.

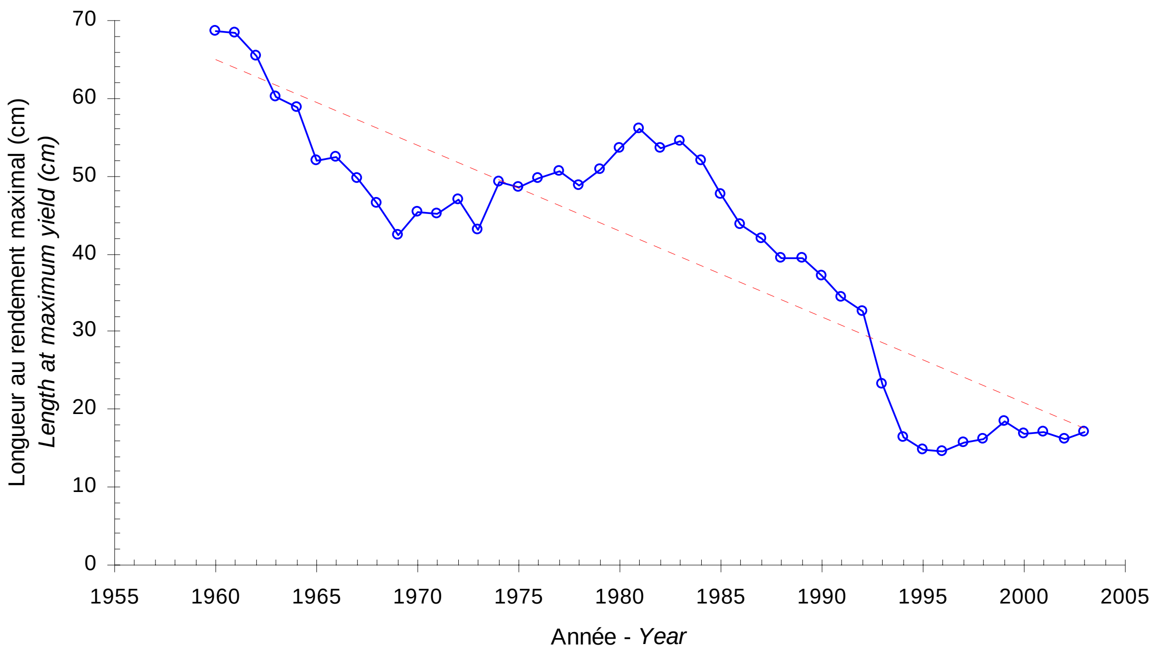

Figure 12 : Tendance générale de la longueur au rendement maximum moyen pondéré des pêches du golfe du Saint-Laurent.
Figure 12 : Overall trend in the weighted length at maximum yield of the Gulf of St. Lawrence fisheries.

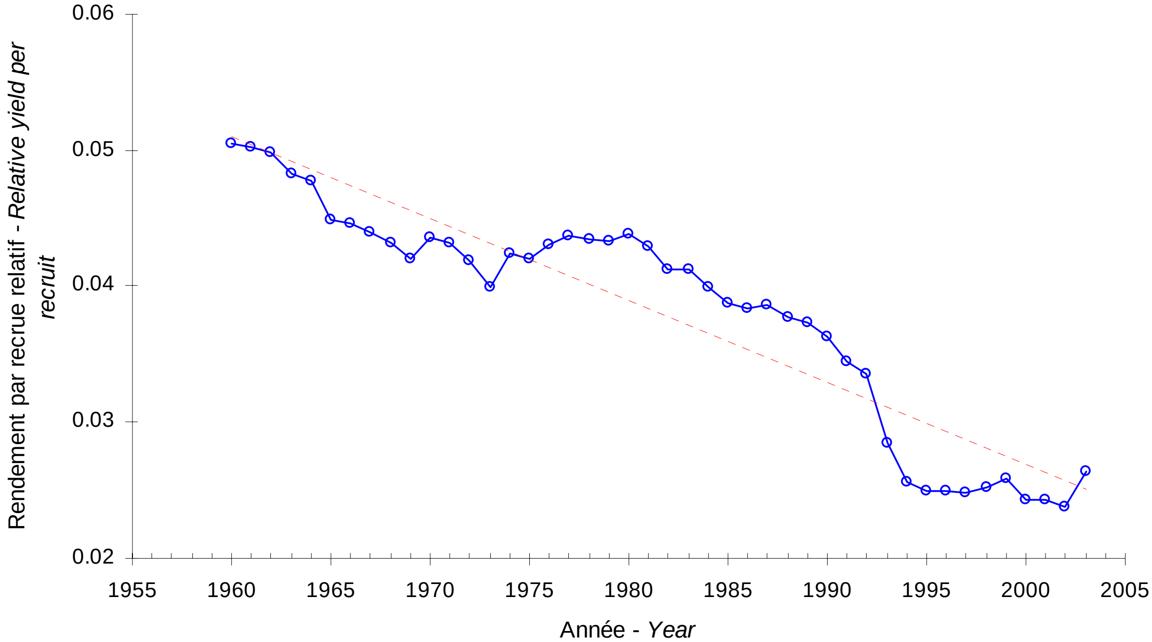

Figure 13 : Tendance générale du rendement par recrue relatif moyen pondéré des pêches du golfe du Saint-Laurent.
Figure 13 : Overall trend in the weighted relative yield per recruit of the Gulf of St. Lawrence fisheries.

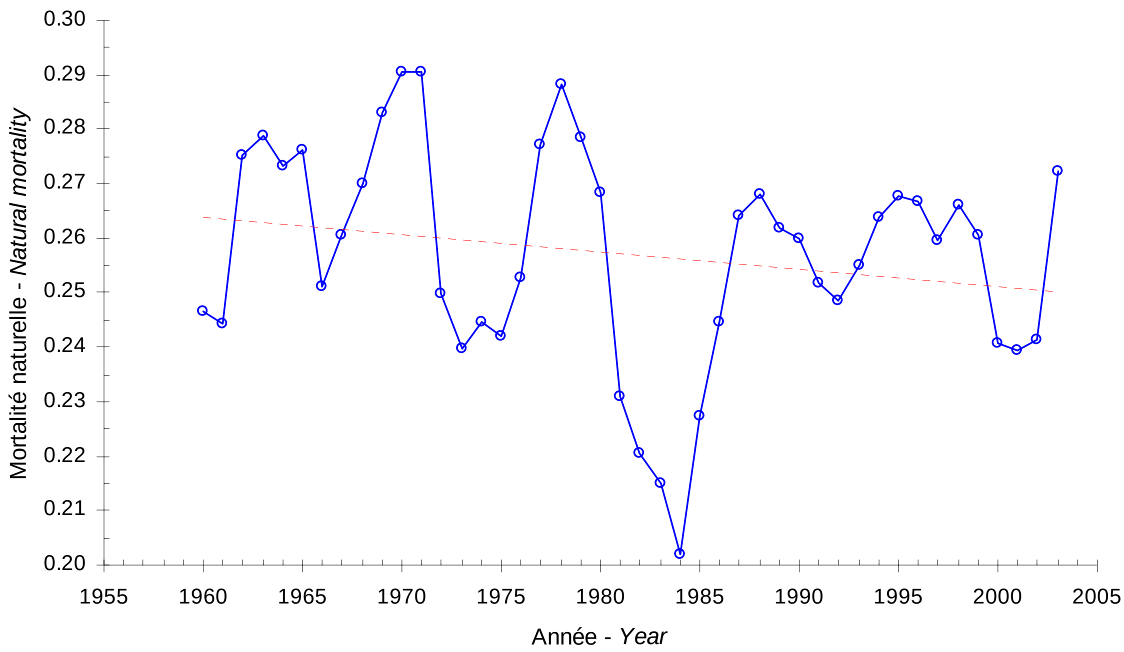

Figure 14 : Tendance générale de la mortalité naturelle moyenne pondérée des pêches du golfe du Saint-Laurent.
Figure 14 : Overall trend in the natural mortality of the Gulf of St. Lawrence fisheries.

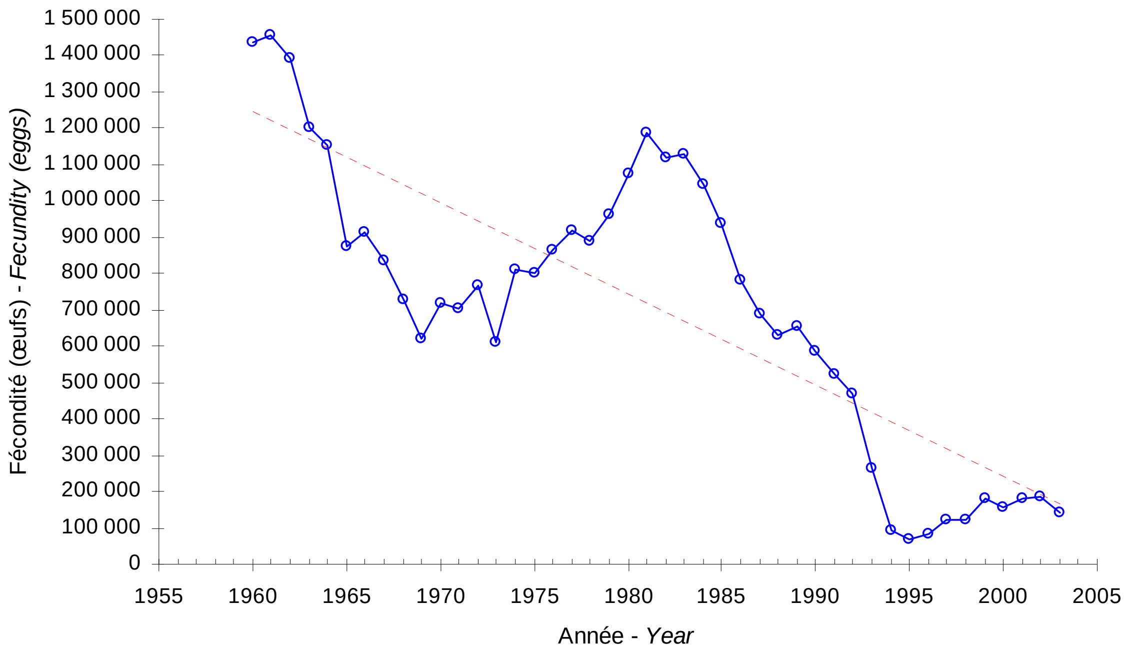

Figure 15 : Tendance générale de la fécondité moyenne pondérée des pêches du golfe du Saint-Laurent.
Figure 15 : Overall trend in the weighted fecundity of the Gulf of St. Lawrence fisheries.

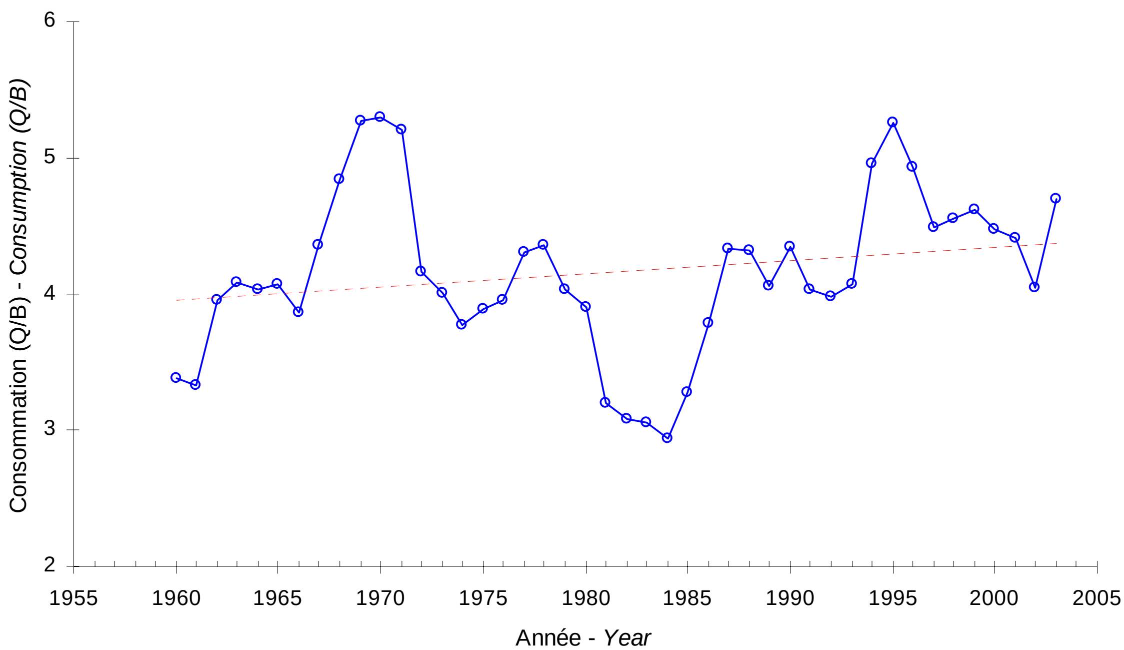

Figure 16 : Tendance générale de la consommation moyenne pondérée des pêches du golfe du Saint-Laurent.
Figure 16 : Overall trend in the weighted consumption of the Gulf of St. Lawrence fisheries.

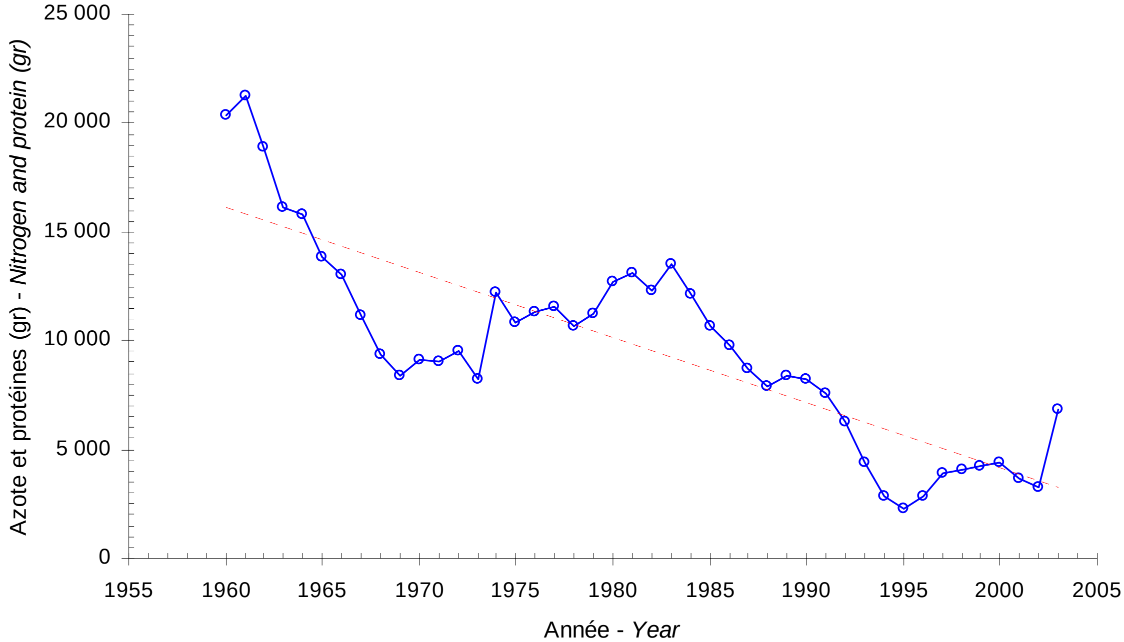

Figure 17 : Tendance générale du contenu en azote et protéine moyen pondéré des pêches du golfe du Saint-Laurent.
Figure 17 : Overall trend in the weighted nitrogen and protein of the Gulf of St. Lawrence fisheries.

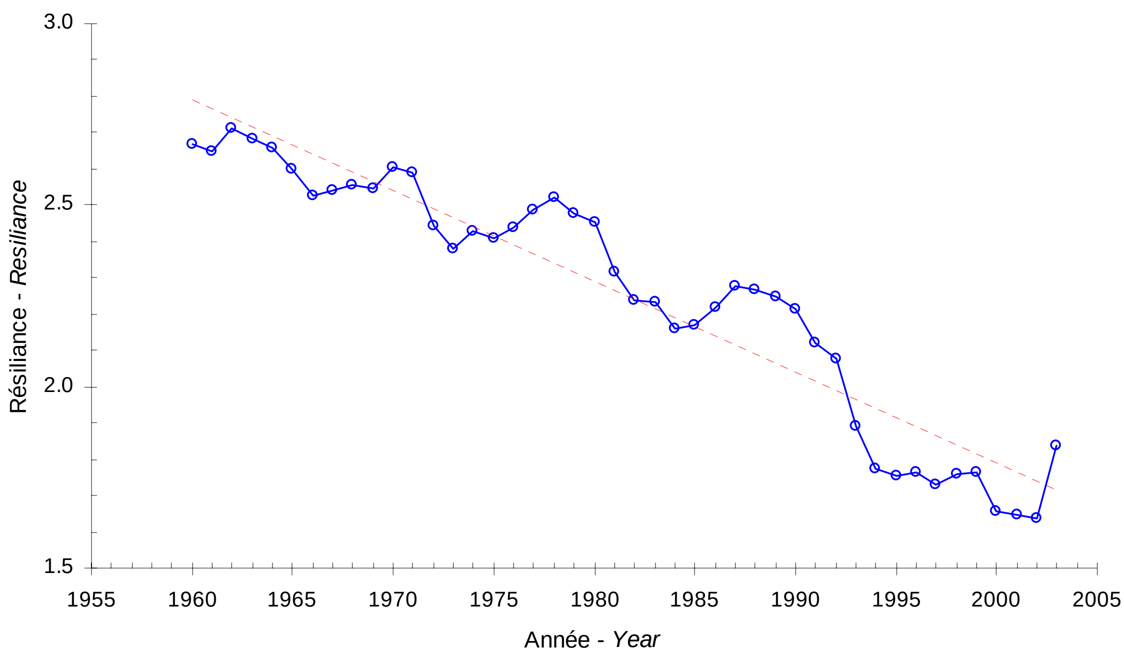

Figure 18 : Tendance générale de la résilience moyenne pondérée des pêches du golfe du Saint-Laurent.
Figure 18 : Overall trend in the weighted resilience of the Gulf of St. Lawrence fisheries.

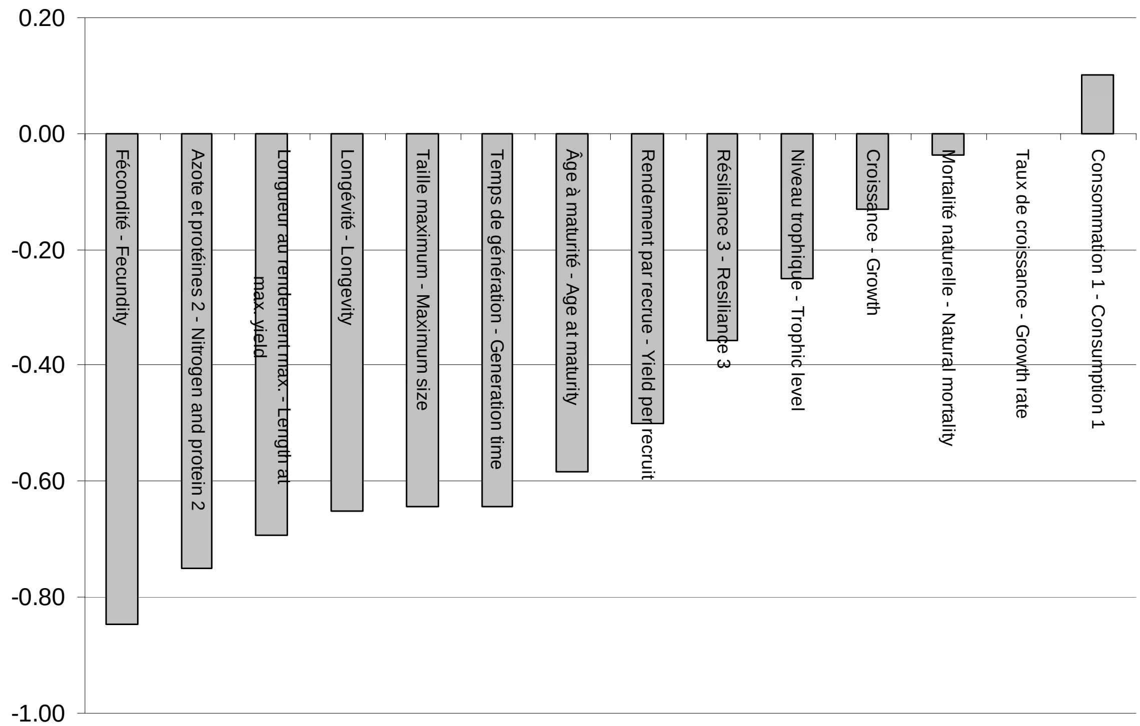

Figure 19 : Résumé des changements observés (%) des caractéristiques biologiques des débarquements des pêches du golfe du Saint-Laurent de 1960 à 2003.
Figure 19 : Summary of the observed changes (%) in the biological characteristics of the landings of the Gulf of St. Lawrence fisheries from 1960 to 2003.

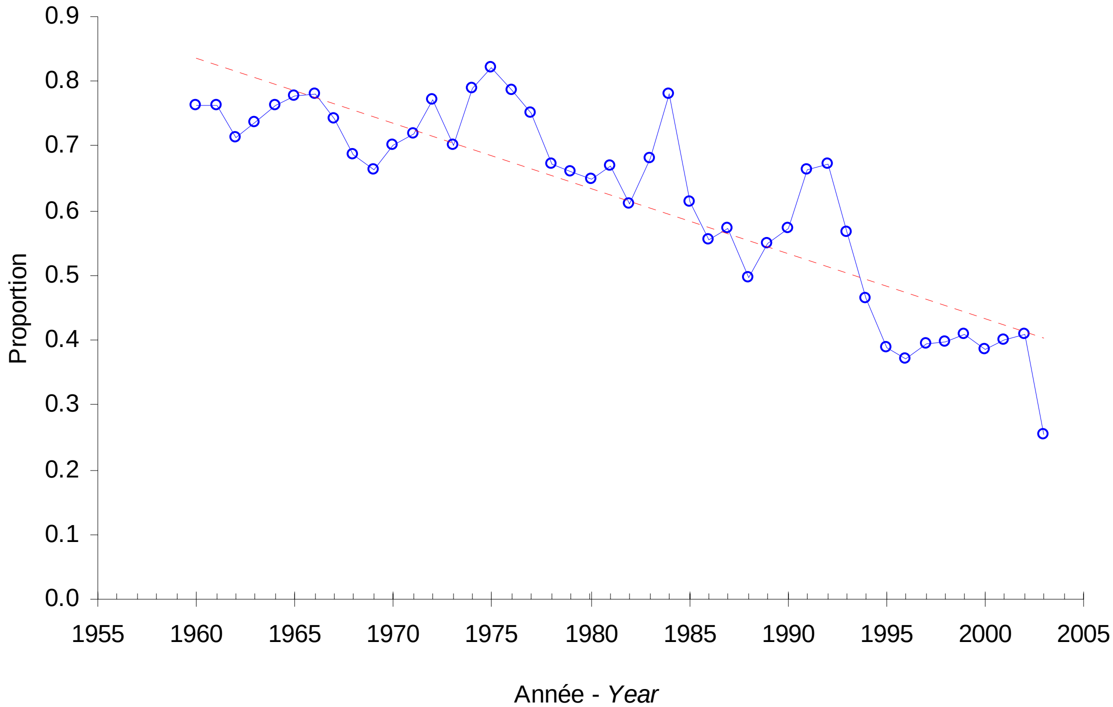

Figure 20 : Proportion des débarquements totaux du golfe effectués par engins mobiles. Données incomplètes pour 2003. (Source : Statlant 21b de l'OPANO)
Figure 20 : Proportion of total landings done by mobile gear in the Gulf of St.-Lawrence. Incomplete data for 2003 (Source: NAFO Statlant 21b).

Annexe 1

Annex 1

Estimation of Life-History Key Facts

Best estimates with error margin

About 7,000 species of fishes are used by humans for food, sports, the aquarium trade, or are threatened by environmental degradation. However, life history parameters such as growth and size at first maturity, which are important for management, are known for less than 2,000 species. We therefore created a life history ‘Key Facts’ page that strives to provide estimates with error margins of important life-history parameters for all fishes (select a species and click on the **Key facts** link). It uses the ‘best’ available data in FishBase as defaults for various equations, as explained below. Users can replace these defaults with their own estimates and recalculate the parameters. For most parameters, we present the range of the standard error of the estimate, which contains about 2/3 of the range of the observed values. We will gradually replace these with estimates of the 95% confidence limits, derived from the standardized residuals. We hope the Key Facts will prove useful to managers and conservationists in species-rich and data-poor tropical countries.

Life history parameters

Max. length: The maximum size of an organism is a strong predictor for many life history parameters (e.g., Blueweiss et al. 1978). The default value used here is the maximum length (L_{max}) ever reported for the species in question, which is in principle available for all species of fish. If no other data are available, this value is used to estimate asymptotic length (L_{inf}), length at first maturity (L_m), and length of maximum possible yield (L_{opt}), as defined in more detail below. However, L_{max} may be much higher than the maximum length reached by the fish population being studied by the user, in which case the derived estimates will be unrealistically high. If additional maximum size estimates for different areas are available in FishBase, a click on the **Max. size data** link displays a list that can be used to replace the L_{max} value with more appropriate estimates. If the **Recalculate** button in the **Max. length** row is clicked, L_{inf} , L_m and L_{opt} are recalculated.

Growth can be estimated from age and size at first maturity

L infinity: This is the length (L_{inf}) that the fish of a population would reach if they were to grow indefinitely (also known as asymptotic length). It is one of the three parameters of the von Bertalanffy growth function: $L_t = L_{inf} (1 – e^{–K(t-to)})$; where L_t is the length at age t (see below for definitions of K and t_0). If one or more growth studies are available in FishBase, L_{inf} of the population with the median Ø’ (see definition below) is taken. Users can click on ‘Growth data’ to see a list of the different estimates of L_{inf} for different populations, i.e. from different localities, of the species in question. If no growth studies are available, L_{inf} and the corresponding 95% confidence interval are estimated from maximum length using an empirical relationship between L_{inf} and L_{max} (Froese and Binohlan 2000). Users can change the L_{inf} value and click the **Recalculate** button to update all parameters depending on L_{inf}.

K: This is a parameter of the von Bertalanffy growth function (also known as growth coefficient), expressing the rate (1/year) at which the asymptotic length is approached. The default value of K is calculated using the L_{inf} provided above and a median value of Ø’ = log K + 2 log L_{inf} (see Pauly et al. 1998) from growth studies available in FishBase for the species. Users can click on the 'Growth data' link to see different estimates of K and Ø’ for different populations. Users can change the value of Ø’ and click the 'Recalculate' button to update the values of K, t_0 (see below), natural mortality, life span, and generation time. If no growth studies but data on L_m and t_m are available for a species, these are used to estimate K from the approximation: $K = -ln(1 - L_m / L_{inf}) / (t_m - t_0)$. If there are no available growth and maturity data but an estimate of maximum age (t_{max}) is available, this is used to calculate K from the equation $K = 3 / (t_{max} - t_0)$. If data for maturity or maximum age are not available in FishBase, users can enter their own estimates to calculate growth. Pauly et al. (1998) have shown that closely related species have similar values of Ø’, even if their L_{inf} and K values differ. We are working on an option to estimate K, in the absence of data, from the maximum length, and the median Ø’ of species from the same genus or family and in the same climate zone.

t_0: This is another parameter of the von Bertalanffy growth function which is defined as the hypothetical age (in years) the fish would have had at zero length, had their early life stages grown in the manner described by the growth equation— which in most fishes is not the case. Its effect is to move the whole growth curve sideways along the X-axis without affecting either L_{inf} or K. Many growth studies use methods that do not provide realistic estimates of t_0 and thus result in ‘relative’ age at length. To improve the estimation of life span and generation time below, we use an empirical equation (Pauly 1979) to estimate a default value for t_0 from L_{inf} and K. This has the form: $\log (-t_0) = -0.3922 - 0.2752 \log L_{inf} - 1.038 \log K$. Users can replace the default value and recalculate life span and age at first maturity.

Natural morality

Natural mortality: The instantaneous rate of natural mortality (M; 1/year) refers to the late juvenile and adult

can be estimated from maximum length and water temperature

phases of a population and is calculated here from Pauly's (1980) empirical equation based on the parameters of the von Bertalanffy growth function and on the mean annual water temperature (T), using a re-estimated version that analyzes a larger dataset and provides confidence limits. The **Growth data** link shows other estimates of M and water temperature. Users can change the values for L_{inf}, K and annual water temperature and recalculate the value of M. If no estimate of K is available, M is calculated from the preliminary empirical equation: M = 10^(0.566 - 0.718 * log(L_{inf}) + 0.02 * T (Froese et al. in prep.). Note that the length type for calculating M has to be fork length for scombroids (tuna and tuna-like fishes) and total length for all other fishes. Length is used here mainly as a 'proxy' for weight. Thus, natural mortality will be underestimated in eel-like fishes and overestimated in sphere-shaped fishes.

Life span: This is the approximate maximum age (t_{max}) that fish of a given population would reach. Following Taylor (1958), it is calculated as the age at 95% of L_{inf}, using the parameters of the von Bertalanffy growth function as estimated above, viz.: $t_{max} = t_0 + 3 / K$.

L maturity: This is the average length (L_m) at which fish of a given population mature for the first time. The value and its standard error are calculated from an empirical relationship between length at first maturity and asymptotic length L_{inf} (Froese and Binohlan 2000). Additional information on maturity, when available, can be displayed by clicking on the **Maturity data** link.

Age at first maturity: This is the average age at which fish of a given population mature for the first time. It is calculated from the length at first maturity using the inverse of the von Bertalanffy growth function, viz.: $t_m = t_0 - \ln(1 - L_m / L_{inf}) / K$.

L_{opt} is the length class giving highest yield

L max. yield: This is the length class (L_{opt}) with the highest biomass in an unfished population, where the number of survivors multiplied with their average weight reaches a maximum (Beverton 1992). A fishery would obtain the maximum possible yield if it were to catch only fish of this size. Thus, fisheries managers should strive to adjust the mean length in their catch towards this value. They can also use L_m and L_{opt} to evaluate length-frequency diagrams for signs of growth overfishing (capturing fish before they have realized most of their growth potential) and recruitment overfishing (reducing the number of parents to a level that is insufficient to maintain the stock and hence the fishery; see Fig. 33). If no growth parameters are available, L_{opt} and its standard error are estimated from an empirical relationship between L_{opt} and L_{inf} (Froese and Binohlan 2000). Otherwise, L_{opt} is estimated from the parameters of the von Bertalanffy growth function and natural mortality as: $L_{opt} = L_{inf} * (3 / (3 + M/K))$ (Beverton 1992).

Relative yield-per-recruit: The main reason why fisheries scientists study the growth of fishes and describe it in the form of the von Bertalanffy growth function, is to perform stock assessment using the yield-per-recruit (Y/R) model of Beverton and Holt (1957). We implemented the simplified version that estimates relative yield-per-recruit (Y'/R) as a function of the mean length at first capture (L_c), L_{inf}, M, K and the exploitation rate (E; see below) (Beverton and Holt 1964). The value for exploitation rate is set at E = 0.5 as a default, but see discussion below. The default value for L_c is set equal to 40% of L_{inf}. This is based on a preliminary investigation of the L_c / L_{inf} ratio for 34 stocks ranging in size from 15 to 184 cm maximum length and which give a range of L_c/L_{inf} values between 0.15 and 0.74. Users can enter other values for their respective fisheries and calculate the corresponding relative yield-per-recruit. For the respective L_c the corresponding maximum and optimum exploitation rates and fishing mortalities (F) are shown (see next paragraph for discussion). Relative yield-per-recruit values can be transformed to absolute yield-per-recruit in weight by the relationship: Y/R = Y'/R * (W_{inf} * e^-(M(t_r-t_0))); where W_{inf} is the asymptotic weight and t_r is the mean age at recruitment. The Y'/R function can be used to estimate the proportion by which the relative yield will increase if the mean size at first capture is closer to L_{opt} and the exploitation rate is closer to the one producing an optimum sustainable yield (see discussion of exploitation rate below). Note that yield-per-recruit analysis assumes relatively stable recruitment even at very small stock sizes, which is often not the case (see paragraph on resilience / productivity below).

Exploitation rate: This is the fraction of an age class that is caught during the life span of a population exposed to fishing pressure, i.e., the number caught versus the total number of individuals dying due to fishing and other reasons (e.g., Pauly 1984). In terms of mortality rates, the exploitation rate (E) is defined as: $E = F / (F + M)$; where M is the natural mortality rate and F the rate of fishing mortality. Gulland (1971) suggested that in an optimally exploited stock, fishing mortality should be about equal to natural mortality, resulting in a fixed E_{opt} = 0.5. This value is still used widely but has been shown to overestimate potential yields in many stocks by a factor of 3-4 (Beddington and Cooke 1983). For small tropical fishes with high natural mortality the exploitation rates at maximum sustainable yield (E_{MSY}) may be unrealistically high. We therefore provide an estimate of the exploitation rate E_{opt} corresponding to a value that is slightly lower than E_{MSY} and which is the exploitation rate corresponding to a point on the yield-per-recruit curve where the slope is $1/10^{th}$ of the value at the origin of the curve. Users are able to change the value of L_c and calculate the corresponding values of E_{MSY} and E_{opt}. We also provide the corresponding values of F_{MSY} and F_{opt} through the relationship: $F = M * E / (1 – E)$.

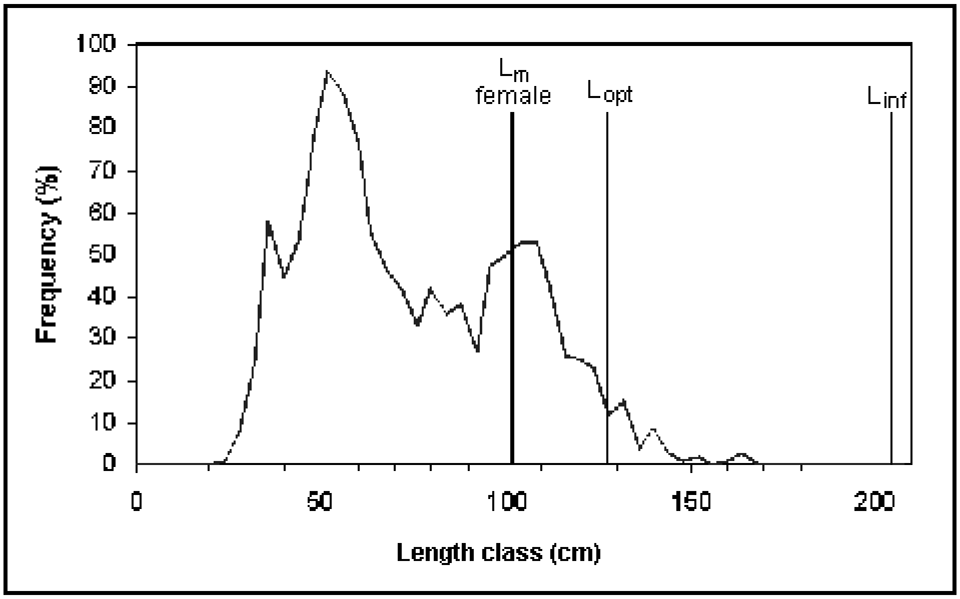

Fig. 33. Length-frequency data of commercial Nile perch catches in Lake Victoria (Asila and Ogari 1988) plotted in a simple framework indicating L_∞ , L_m and L_{opt}. Note that the length distribution indicates growth and recruitment overfishing. The yield could be increased by a factor of about 2.4 if all fishes smaller than L_{opt} were caught at a length between L_m and L_{opt}.

Estimate exploitation rate from mean size in catch

Estimation of exploitation rate from mean length in catches: Beverton and Holt (1956) showed that for fish that grow according to the von Bertalanffy growth function, total mortality (Z) can be expressed by: $Z = K * (L_{inf} – L_{mean}) / (L_{mean} – L')$, where L_{mean} is the mean length of all fishes caught at sizes equal or larger than L', which is the smallest size in the catch and here assumed to be the same as L_c, which is the mean length at entry in the fishery, assuming knife-edge selection, and thus the same as used under Yield per Recruit above. All other parameters are as defined above. Users can enter observed values of L_c and L_{mean} for a given fishery, as may be estimated from length-frequency samples, and calculate total mortality Z, fishing mortality F = Z – M, and exploitation rate E = F / Z. The estimate of F or E can then be compared with those at maximum sustainable yield and optimum yield as given in the Relative Yield per Recruit section, thus obtaining a preliminary indication of the status of the fishery. Note, however, that the length-frequencies from which L_c and L_{mean} are derived must be to the furthest extent possible representative of the length-structure of the population under equilibrium, as may be obtained by averaging a long time series of length-frequency samples.

Resilience to fishing pressure

Resilience / productivity: The American Fisheries Society (AFS) has suggested values for several biological parameters that allow to classify a fish population or species into categories of high, medium, low and very low resilience or productivity (Musick 1999; Tab. 1). If no reliable estimate of r_m (see below) is available, the assignment is to the lowest category for which any of the available parameters fits. For each of these categories, AFS has suggested thresholds for decline over the longer of 10 years or three generations. If an observed decline measured in biomass or numbers of mature individuals exceeds the indicated threshold value, the population or species is considered vulnerable to extinction unless explicitly shown otherwise. If one sex strongly limits the reproductive capacity of the species or population, then only the decline in the limiting sex should be considered. We decided to restrict the automatic assignment of resilience categories in the Key Facts page to values of K, t_m and t_{max} and those records of fecundity estimates that referred to minimum number of eggs or pups per female per year, assuming that these were equivalent to average fecundity at first maturity (Musick 1999). Note that many small fishes may spawn several times per year (we exclude these for the time being) and large live bearers such as the coelacanth may have gestation periods of more than one year (we corrected fecundity estimates for those cases reported in the literature). Also, we excluded resilience estimates based on r_m (see below) as we are not yet confident with the reliability of the current method for estimating r_m. If users have independent r_m or fecundity estimates, they can refer to Table 1 for using this information.

Table 1. Values of selected life-history parameters suggested for classifying the resilience / productivity of fish populations or species. See text for definitions and discussion.

Parameter	High	Medium	Low	Very low
Threshold	0.99	0.95	0.85	0.70
r_{max} (1/year)	> 0.5	0.16 – 0.50	0.05 – 0.15	< 0.05
K (1/year)	> 0.3	0.16 – 0.30	0.05 – 0.15	< 0.05
Fecundity (1/year)	> 10,000	100 – 1000	10 – 100	< 10
t_m (years)	< 1	2 – 4	5 – 10	> 10
t_{max} (years)	1 – 3	4 – 10	11 – 30	> 30

r_m is difficult to estimate in fishes

Intrinsic rate of population increase: The intrinsic rate of population growth (r_m; 1/year) has been suggested as a useful parameter to estimate the capacity of species to withstand exploitation (see above). It also largely simplifies the parametrization of Schaefer models for estimating maximum sustainable yield through the relationship MSY = r_m * B_{inf} / 4, where B_{inf} is the maximum biomass of a particular species that a given ecosystem can support (Ricker 1975), often corresponding to the original size of the unfished population. Note that if L_c is close to the average length L_r at which juveniles join the parent stock, then the value of F_{MSY} (above) can be used to estimate r_m from the relationship $r_m = 2 * F_{MSY}$ (Ricker 1975). It seems that 0.4 * L_{inf} is a first approximation of L_r. We are exploring this and other options to estimate r_m. One can calculate the time (t_d) in years that it would take a strongly reduced population to double in numbers if all fishing ends, from $t_d = \ln(2) / r_m$.

Our approach to estimate generation time

Generation time: This is the average age (t_g) of parents at the time their young are born. In most fishes L_{opt} (see above) is the size class with the maximum egg production (Beverton 1992). The corresponding age (t_{opt}) is a good approximation of generation time in fishes. It is calculated using the parameters of the von Bertalanffy growth function as $t_g = t_{opt} = t_0 - \ln(1 - L_{opt} / L_{inf}) / K$. Note that in small fishes (< 10 cm) maturity is often reached at a size larger than L_{opt} and closer to L_{inf}. In these cases, the length class where about 100% (instead of 50%) first reach maturity will contain the highest biomass of spawning fishes, resulting usually in the highest egg production. As an approximation for that length class we assume that most fish will have reached maturity at a length that is slightly longer than L_m, viz.: $L_{m100} = L_m + (L_{inf} - L_m) / 4$, and calculate generation time as the age at L_{m100}. This is applied whenever $L_m >= L_{opt}$.

Length-weight: This equation can be used to estimate the corresponding wet weight to any given length. The default entry is L_{inf}, thus calculating the asymptotic weight for the fish of the population in question. The parameters ‘a’ and ‘b’ are taken from data in FishBase with a median value of ‘a’ and with the same length type (TL, SL, FL) as L_{inf}. Users can click on the ‘Length-weight’ link to see additional data. Users can change the length or the values of ‘a’ and ‘b’ and recalculate the corresponding weight.

Whole-body nitrogen and crude protein: L.J. Ramseyer (2000, in review; see also www.mi.nmfs.gov/Nfish.html) has analysed the relationship between whole-fish wet weight and whole-body nitrogen content for 68 species and hybrids, based on data extracted from the literature. He found the following relationship: log N (g) = 1.03 * (log wet weight) - 1.65; n=2811, r^2=0.996, p<0.001. For the conversion from nitrogen to crude protein he gives the ratio: crude protein = 6.25 * nitrogen. We have added these relationships here for your convenience.

Trophic level: The rank of a species in a food web can be described by its trophic level (troph), which can be estimated as: Troph = 1 + mean trophs of food items; where the mean troph is weighted by the contribution of the various food items (Pauly and Christensen 1998). The default value and its standard error as shown in the Key Facts sheet are derived from the first of the following options that provides an estimate of troph based on: 1) diet information in FishBase, 2) food items in FishBase, and 3) size-adjusted troph estimates from species with relatives for which (1) or (2) are available (see Box 23 where the comparative method for estimating troph is described)].

A simple tool to estimate population food consumption

Food consumption: The amount of food ingested (Q) by an age-structured fish population expressed as a fraction of its biomass (B) is here presented by the parameter Q/B. FishBase contains over 160 independent estimates of Q/B extracted mainly from Palomares (1991) and Palomares and Pauly (1989) and also from Pauly (1989). These estimates were obtained using Pauly's (1986) equation, viz.: Q/B = $[(dW/dt) / K_{1(t)}] / [W_t N_t d_t]$ integrated between the age at which fish recruit (t_r) and the maximum age of the population (t_{max}); where N_t is the number of fishes at age t, W_t their mean individual weight, and $K_{1(t)}$ their gross food conversion efficiency (= growth increment / food ingested). These Q/B estimates are available in FishBase for only 98 species and for most of these, there is only one Q/B estimate per species. In the few species for which several Q/B values are available, the median Q/B value is taken and a 'Food consumption' link is provided to the user for viewing the details of these studies. For other species, Q/B is estimated from the empirical relationship proposed by Palomares and Pauly (1999), viz.: log Q/B = 7.964 – 0.204 log W_{inf} – 1.965T' + 0.083A + 0.532h + 0.398d; where W_{inf} (or asymptotic weight) is the mean weight that a population would reach if it were to grow indefinitely, T' is the mean environmental temperature expressed as 1000 / (C + 273.15), A is the aspect ratio of the caudal fin indicative of metabolic activity and expressed as the ratio of the square of the height of the caudal fin and its surface area, 'h' and 'd' are dummy variables indicating herbivores (h=1, d=0), detritivores (h=0, d=1) and carnivores (h=0, d=0). The default value for W_{inf} is taken either from L_{inf} and the length-weight relationship (see above) or from W_{max} (maximum weight ever recorded for the species) when an independent estimate of W_{inf} is not available in FishBase. Values of A were assigned, for each of the different shapes of caudal fins considered here, using the median A values based on 125 records in FishBase of species with A and caudal fin shape data (from left to right: lunate, forked, emarginate, truncate, round, pointed, double emarginate and heterocercal). Note that five of these eight shapes share the same median value, that which is used as the default A value for the empirical estimation of Q/B when an independent estimate is not available. We are working on a method that will better separate categories of caudal fins. Values of the feeding type indicators 'd' and 'h' are assigned according to which feeding category the species belongs: detritivore, herbivore, omnivore (default) and carnivore. These categories are determined either from the Main food or the Trophic level (detritivores troph < 2.2; herbivores troph < 2.8; carnivores troph > 2.8). When the default category 'Omnivore' is highlighted, Q/B is estimated as the mean of the Q/B values obtained for herbivores and carnivores. The temperature used in the estimation of M above is applied in the empirical estimation of Q/B. The Q/B estimate is automatically recalculated when the tail fin shape and/or the feeding types are changed. The **Recalculate** button is provided when values of W_{inf} and A are re-entered, e.g., in cases where no possible/guessed values of W_{inf} are available in FishBase.

Comments

The Key Facts page is still very much evolving and we welcome comments and suggestions for its further improvement to any of the authors.

Acknowledgments

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How to get there

You get to the KEY FACTS routine by clicking on the respective button in the BIOLOGY window of the species in question.

Internet

On the Internet, you get to the 'Key Facts' page by clicking the respective link in the 'More information' section of the 'Species Summary' page. Note that you can save the Key Facts page to your harddisk and that it will function off-line.

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