

THE USE OF PATENT DATABASES TO PREDICT TRENDS IN THE KRILL FISHERY

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Abstract

The fishery for Antarctic krill (*Euphausia superba*) caught 210 000 tonnes in 2009/10 with vessels from six of CCAMLR's 25 Members participating in the fishery. Trends in the krill fishery are currently informed by data on annual catches and by CCAMLR's annual notification procedure. There has been considerable discussion within the Scientific Committee over the utility of these sources of information to detect trends in the fishery, and of the need to obtain more information from the krill industry so that developments that affect future catches can be predicted. This paper uses publicly available patent databases to examine both the number and type of patents related to krill that are lodged annually. This information shows similar trends to the catch and notification information, and the three sources of information can be used in combination to provide information to the Commission on potential changes in the krill fishery. The Scientific Committee has recommended that the patent database be maintained by the Secretariat so that it can annually update a register of krill-related patents which will be of use for indicating potential future trends in the krill fishery.

Keywords: Antarctic krill, fishery, patents, trends, management, CCAMLR

Introduction

There has been increasing concern amongst the scientific community and those responsible for the management of the Antarctic krill (*Euphausia superba*) fishery that the harvesting of this species will soon increase to unprecedented levels (Schiermeier, 2010a). This concern has been prompted by numerous factors, including, but not limited to, increased and diversified participation in the fishery, advances in technology, the rapid decline of global fish stocks and an ever-increasing global population (Nicol et al., 2011). CCAMLR aims to manage the krill fishery in line with its precautionary and ecosystem-based approach to management.

The krill fishery is unique because the current level of catch (210 000 tonnes) is only a fraction of the estimated precautionary catch limit (8.6 million tonnes), thus there is considerable room for expansion of the fishery. Given CCAMLR's mandate for precautionary management, it is essential that the fishery develops in an orderly fashion and this requires information on the potential rate of expansion of the fishery so that the Commission can set in place the appropriate management measures. Currently, however, there is very limited information available to the Commission on any of the factors that might drive an increase in the fishery for Antarctic krill, so the ability to respond to potential changes is limited.

Table 1: Information requested by the Scientific Committee on the economics of the Antarctic krill fishery, as recorded in Scientific Committee reports.

Information requested	Year	Report reference
Past and current krill market information.	1998	SC-CAMLR, 1998, paragraph 2.6
Past and current market prices for krill products.	1999	SC-CAMLR, 1999, paragraph 2.7
Past and current market prices for krill products.	2000	SC-CAMLR, 2000, paragraphs 2.4–2.6
Updated information on krill processing, market developments, economic analyses.	2001	SC-CAMLR, 2001, paragraph 2.4
Information on economics of the fishery and market developments.	2001	SC-CAMLR, 2001, paragraph 3.8
Information on commercial market prices, economic marketing, technological information and demand for aquaculture feeds.	2002	SC-CAMLR, 2002a, paragraph 4.11
Ability to predict trends in the fishery still hampered by a lack of information on technological and economic developments.	2004	SC-CAMLR, 2004, paragraph 4.17
Noted change in pattern of fishery operation in regards to participants, products composition and harvesting technologies.	2005	SC-CAMLR, 2005, paragraph 4.11
Noted that new products, particularly oil and pharmacological products, appear to be driving interest in the fishery.	2007	SC-CAMLR, 2007, paragraph 4.9
Information on how publicly available information in trade press etc. may be used to inform deliberations of the working groups.	2008	SC-CAMLR, 2008, paragraph 4.9

CCAMLR currently uses two primary tools for monitoring and predicting trends in the fishery for Antarctic krill: reports of annual catches and notifications of intent to participate in the fishery. Catches reported by Members involved in the fishery (Figure 1) have shown a slight upward trend since 2003. Notifications of intent to fish (Figure 1), however, rose dramatically from a notified catch of around 165 000 tonnes for the 2000/01 season to a notified catch of over 750 000 tonnes for the 2007/08 season, a projected catch level that would exceed the trigger level of 620 000 tonnes, set by the Commission for Area 48.

Since formal notifications began in 2003 the projected catch has always been higher than the actual catch reported the following season. There are a number of reasons for this: fishing nations do not want to notify a catch level that may restrict their activities if conditions are good, nations may intend to go fishing but for operational reasons may not send vessels to the Southern Ocean and conditions on the fishing grounds may be sub-optimal. This discrepancy between the predicted and actual catches has been discussed by the Scientific Committee (SC-CAMLR, 2008, paragraph 4.8)

and there have been attempts to ensure that notifications are more informative and accurate. Notifying Members have been requested to provide information on: numbers of vessels, names of vessels and vessel information, areas of operation, expected level of catch, months during which fishing will take place, net configuration, use of fishing techniques and the product types to be derived from catches. On several occasions the Scientific Committee has recognised the need for Members to provide more detailed information on their krill fisheries in order to ensure the orderly development of the fishery and to meet CCAMLR's management objectives. Information on past and current krill market prices, products and other market drivers has been requested on several occasions by the Scientific Committee (Table 1). In response to such requests, limited information has been provided by some Members (SC-CAMLR, 1998, paragraph 2.5; SC-CAMLR, 1999, paragraph 2.6; SC-CAMLR, 2000, paragraph 2.5) but there is no requirement for systematic submission of such data and no acknowledged methodology for obtaining it.

As a response to these continued calls for market information, a paper on detecting trends in the krill fishery was submitted to WG-EMM in 2002 (Nicol and Foster, 2002). This outlined the prospect of using publicly available patent databases to construct a database of krill-specific patents from which trends in product types, countries and companies with a potential interest in participating in the krill fishery, could be identified.

A patent is a right granted for any device, substance, method or process which is new, inventive and useful, is legally enforceable and gives the owner the exclusive right to commercially exploit the invention for the life of the patent (Intellectual Property (IP) Australia, 2010). Records of patents that have been granted are kept in publicly accessible online databases and contain all information necessary for distinguishing each patent as unique, including description of methods, ingredients and research results. Patents are generally applied for when the Applicant sees a future commercial gain from the development of the patented product. Under Australian law, a patent gives the Applicant control over, and protection of, the patented technology for 20 years (IP Australia, 2010); similar provisions apply in other countries.

There have been many studies which have used publicly available patent databases to investigate rates of technological change and patenting activity occurring in different industries, including the whaling, fisheries and pharmaceutical industries, as well being used in the analysis of economic progress for entire economies (Gupta and Manchikanti, 2010; Hidalgo et al., 2010; Ninan and Sharma, 2006; Basberg, 1981). Patents and patent databases are also increasingly being used for detecting investor interest in emerging technologies (Schiermeier, 2010b) and for identifying products and technologies relating to particular ingredients (Darby, 2010). Whilst using patents to predict commercialisation and emerging technologies is still an emerging technique (Pilkington, 2004), the information contained within the patents can be used to gather simple information for answering the basic questions of who, what, where, when and why; for example:

- Who: under the title of Applicant(s) or Inventor(s) both the name of the Company who

‘owns’ the patent, and often the name of individuals involved in developing the product/technology, are cited.

- What: detailed information on what product/technology is involved in the patent is given in the Title, Description and Claims sections of the patent.
- Where: in the Applicant(s) and Inventor(s) titles, the country of both is given alongside the names.
- When: information on when the patent was first lodged and when it was granted is available under the Publication Date, Application Number and Priority Number titles.
- Why: the Classification assigned to the patent by patent offices describes the intended area of application for the patent.

Both WG-EMM (SC-CAMLR, 2002b, paragraphs 2.47 and 2.48) and the Scientific Committee (SC-CAMLR, 2002a, paragraphs 4.9 to 4.11) recognised the importance of the information presented by Nicol and Foster (2002) in providing insight into developments in the industry that could lead to future expansion of the krill fishery. The analyses in this paper were subsequently published in Nicol and Foster (2003).

Analysis of the krill patent database constructed in 2002 (Nicol and Foster, 2003) indicated a number of trends relevant to the deliberations of the Scientific Committee:

- (i) a total of 376 krill-related patents were lodged from 1934 to 2002
- (ii) traditional fishing nations, particularly Japan, had lodged most patents in the early half of the dataset
- (iii) there was an increasing trend in the later years for non-traditional fishing nations to be involved
- (iv) the majority of patents were directed at the use of krill for human consumption, with the next most numerous being those directed at uses in the production of feed and bait

- (v) There was an increasing trend in the later years for patents directed at using krill for medical purposes.

This paper is a continuation of the approach of Nicol and Foster (2003), identifying trends from an updated version of the krill patent database. The paper also examines whether the increase in krill fishery notifications made to the Commission is matched by an increase in patent activity. Finally, the paper suggests that an annually updated patent database would provide the Scientific Committee with an additional tool for examining possible future directions of the Antarctic krill fishery.

Materials and methods

The original krill patent database (Nicol and Foster, 2002) was constructed using patents from the European, Japanese and US patent offices. The database has now been updated to include all krill-related patents from 1976 to March 2009, but only the European and US patent office databases were used in the patent search. This alteration in the scope of databases searched is because the European and US patent offices are the primary patent offices with which to lodge patents to obtain the best scope for coverage of new technologies, and are thus readily searched. Because this patent database is primarily intended to be an index of interest in the krill industry, rather than a comprehensive survey of all krill patents, consistency, reliability and ease of access guided the selection of source material. The updated database was constructed after extensive consultation with patent and IP professionals at IP Australia, to ensure the highest possible degree of coverage and reliability of data.

The databases were searched (using the patent search engine at http://ep.espacenet.com/?locale=en_EP and <http://patft.uspto.gov/>) using key search phrases to include all issued patents containing the phrases 'krill' and/or '*Euphausia superba*' in the title or abstract. This search method means that patents referring only obliquely to krill in a reference or example are excluded from the total number of patents, therefore avoiding over-representation of krill-related patents. However, a noted drawback of this search method is that some patents which are known to apply to krill technologies, but do not mention krill in their title or abstract, are excluded from the patent total (for example, the patent lodged by AKER Biomarine ASA in 2008

(WO2008048107) relating to the continuous pumping system). Even though some technologies, such as that presented in Aker's 2008 patent, may not pertain directly to a marketable krill product, they do represent significant investment by the Assignee in the krill industry (to lodge and maintain a patent is a costly process) and therefore are an indicator of likely future activity in the krill product marketplace. All patents were cross-checked by investigation of the INPADOC (International Patent Documentation Center) patent family (which indicates other countries/patent offices with which the patent has been lodged) to ensure no duplication has occurred, again minimising over-representation of patents. It is worth noting that because of the time between lodging an application and the granting of a patent, and the subsequent appearance of this patent in the database, the last year in any time series always underestimates the number of patents lodged for that year.

Patents identified as being krill-related have been sorted into four main categories with each category representing several different but related groupings of patents. The 'processing' category accounts for patents relating to processing, harvesting, packaging, peeling and preservation techniques as well as patents relating to the extraction of chitin. 'Aquaculture' includes patents related to fishing and aquaculture feed and bait (or attractant) technologies, and patents relating to the extraction and/or use of hydrolysates and pigments. The 'human' category refers to patents related to food for human consumption, and those patents encompassing medical and enzyme-related technologies and products. Finally, 'other' encompasses all other patents, primarily those related to the use of krill in industrial procedures and includes pest control devices and products.

Results

A total of 812 krill-related patents were lodged between 1976 and March 2009. This represents a substantial increase from the 376 patents which were identified in the 2002 database (Figure 2). A total of 351 patents have been lodged since 1999 (43% of all patents) as opposed to around 230 (28% of total patents) patents lodged in each of the two previous 10-year periods. There has been a notable increase in the rate of patent lodging since 2000.

The composition of the technologies the patents represent shows an obvious trend (Figures 3 to 5). Patents related to processing dominated applications from the 1976 to 1986 period (50% of total patents) and showed a marked decline thereafter (only 11% of total patents from 1987 to 2008). In contrast, patents for Aquaculture and Human Uses for krill markedly increased in the 1999–2008 period (89% of total patents), having represented only 61% of total patents in the 1976–1998 period.

A clear trend of an increase in patents relating to Medical Use is evident when the Human Use category is subdivided into patents relating to technologies/products for Food and those relating to Medical Uses (Figure 6).

Patents relating to Medical Uses represented only 4% of total patents from 1976 to 1986 but 38% from 1999 to 2008. In contrast, patents relating to Food technologies/products have declined; they represented 35% of patents from 1976 to 1986 compared to only 11% of patents lodged from 1999 to 2008.

This patent database can also be used to analyse the patent activity of different nations. The most 'patent active' countries over the life of the database are Poland, Canada, USA and Japan. Predictably, Japan, the most persistent fishing nation, has been the most active country, with Japanese companies lodging 49% of the total patents, and companies from the USA lodging 21%, Poland lodging 7% and Canada lodging 4% of total patents. If this information is broken down to identify trends over the period of the database, it can be seen (Figure 7) that the proportion of patents lodged by Japan is showing a downward trend, whilst the proportion of total patents lodged by the USA and Canada is showing an upward trend.

Discussion

There has been an increase in the rate of patent applications related to krill over recent years. Since 2002, the nature of patents has shifted slightly with a further decrease in patents relating to Processing technologies/products, an increase in the proportion of patents relating to Human Use and a slight decrease in the proportion of patents relating to Aquaculture technologies/products. This is further supported by evidence that the number of patents relating to Feed/Bait technologies/products is showing a steep downward trend, whilst the number of patents relating to Medical Uses shows an upward trend.

It is also evident from analysis of this database that there is increasing patent activity from nations such as USA and Canada which are not currently fishing for krill, and decreasing patent activity from traditional fishing nations such as Japan and Poland. Increased numbers of patents reflect increased global interest in krill as a product and may result in increased participation in the fishery or an increase in market demand for krill products produced by current fishing interests. In this respect it is important for the Scientific Committee to note that there appears to be heightened interest in the krill industry from Members who are not necessarily directly involved in fishing activities. Consequently, it will be increasingly important for the Scientific Committee to develop means by which to monitor the economic drivers of the fishery, rather than having to rely solely on information contained in notifications from fishing Members, if it is to provide advice on the potential rate of development of the fishery.

Conclusion

CCAMLR currently has two primary mechanisms for tracking developments in the krill fishery: catches and catch notifications. Over the past 10 years, both indicators have shown significant upward trends (Figures 8 and 9), suggesting an increase in the level of the fishery in the future.

Analysis of results from this study indicate that there has also been a significant upward trend in the overall number of krill-related patents (Figure 10).

Thus, all three indicators show a similar and statistically significant upward trend over the last 10 years and the patent data reinforces the information from the catch and notification data.

Patent activity is at its highest level ever and the krill industry has been shown to be diversifying in terms of product range and focus – as well as in the nations showing interest in fishing for krill. In 2009 the Scientific Committee recommended that this patent database be transferred to the Secretariat to be regularly updated and used as a tool to track economic drivers of the Antarctic krill fishery (SC-CAMLR, 2009, paragraph 4.12).

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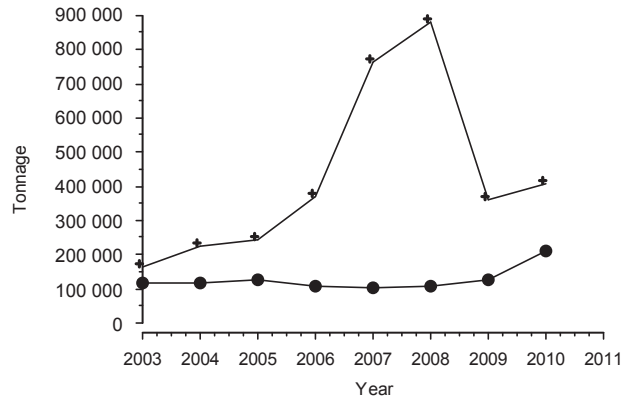


Figure 1: Notified and actual catches of Antarctic krill (*Euphausia superba*) since 2003 when mandatory notification began.

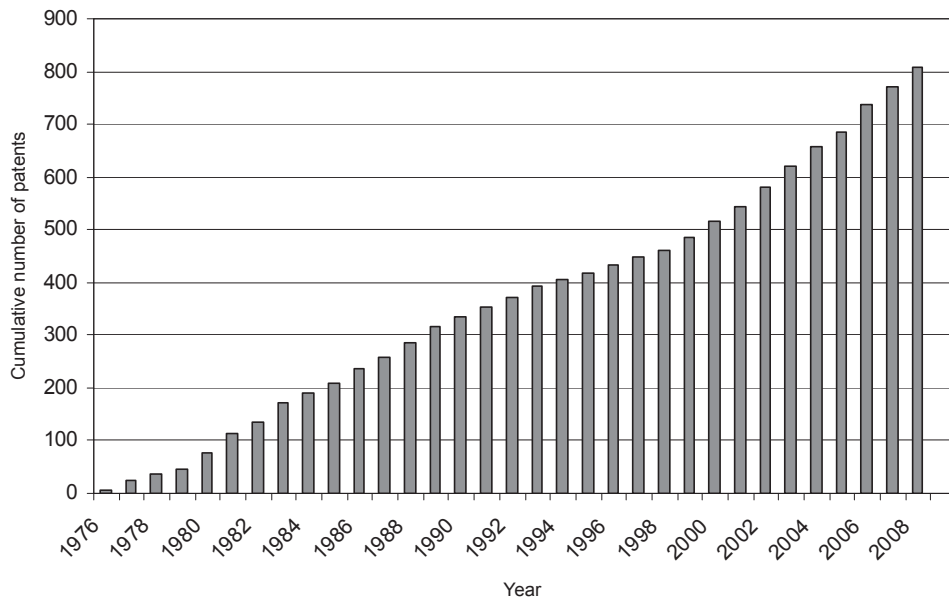


Figure 2: Cumulative number of krill-related patents lodged from 1976 to 2008.

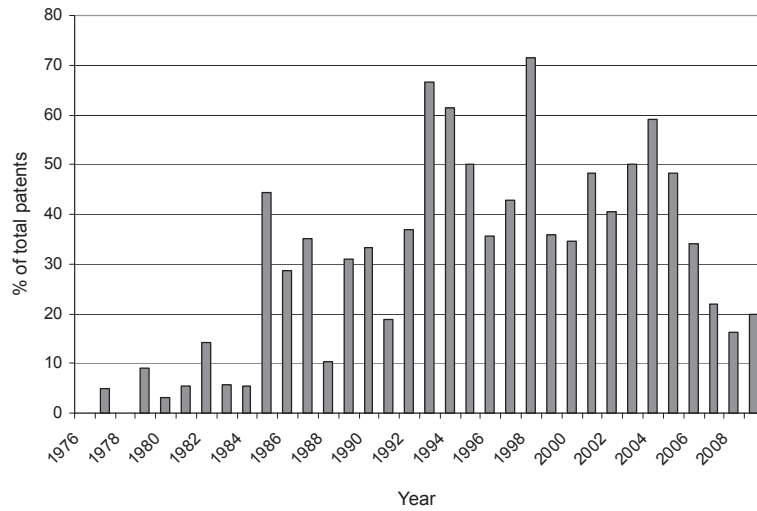


Figure 3: Patents related to uses of krill for Aquaculture purposes, 1973–2008.

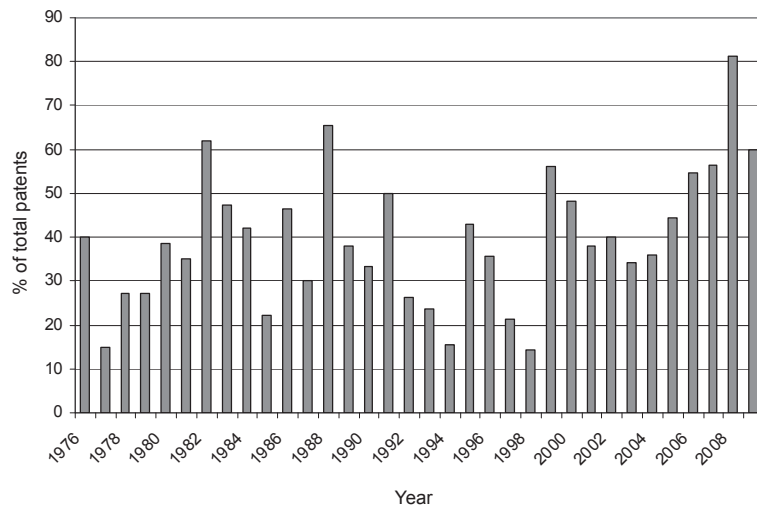


Figure 4: Patents related to uses of krill for Human Use purposes, 1973–2008.

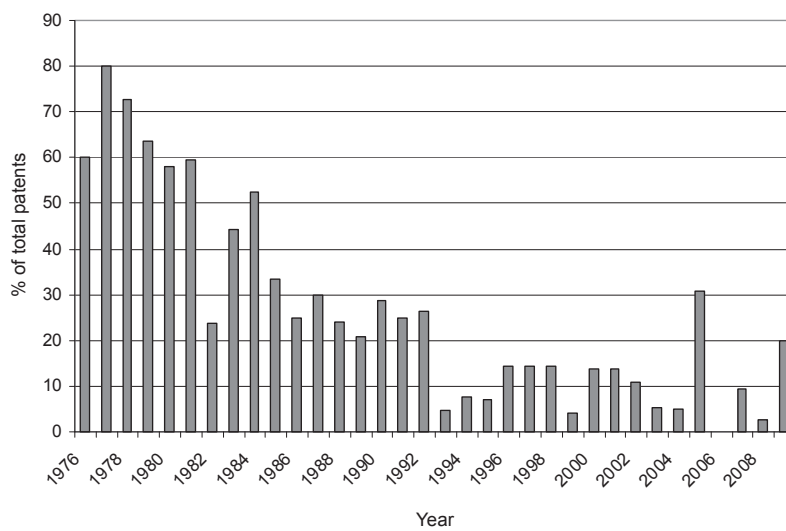


Figure 5: Patents related to uses of krill for Processing Purposes, 1973–2008.

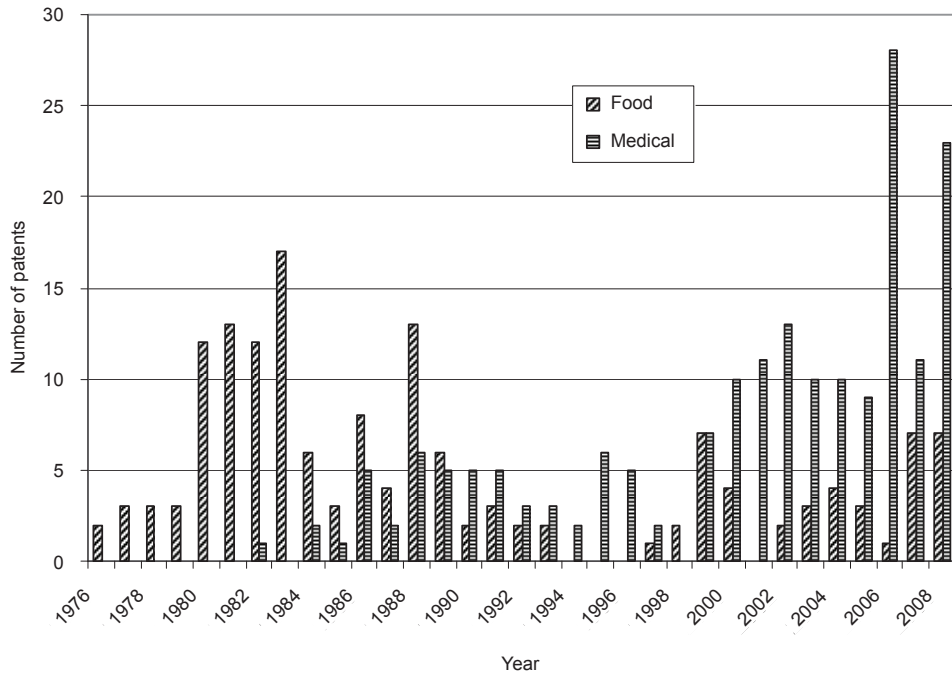


Figure 6: Krill-related patents lodged from 1976 to 2008, categorised into Food and Medical Uses.

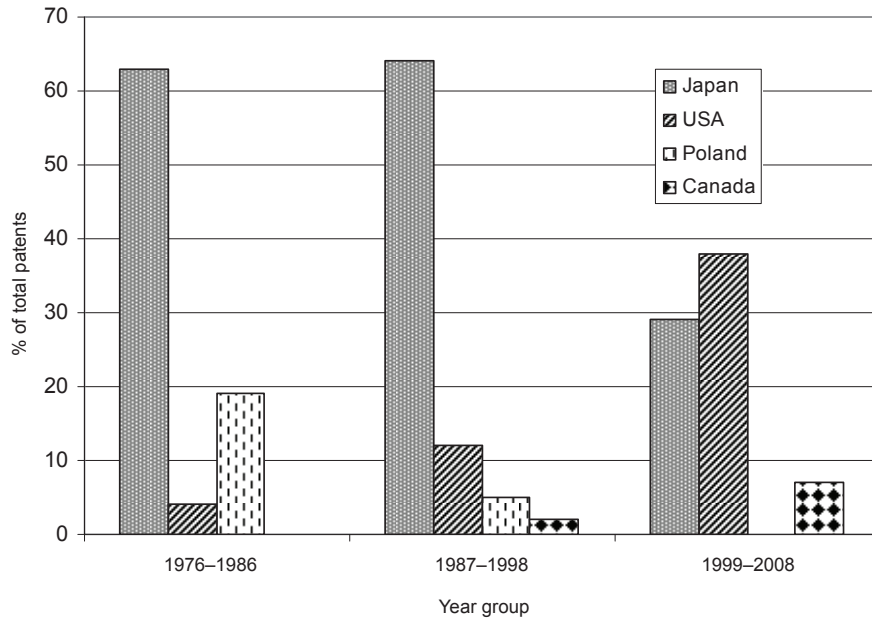


Figure 7: Percentages of total patents lodged by most patent active countries, in year groups.

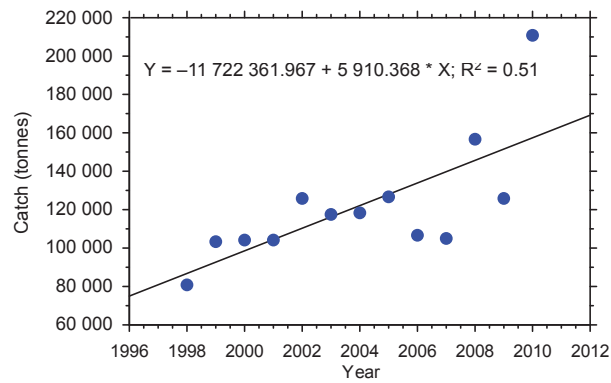


Figure 8: Annual krill catch reported to CCAMLR since 1998. The observed increase is significant ($P < 0.02$).

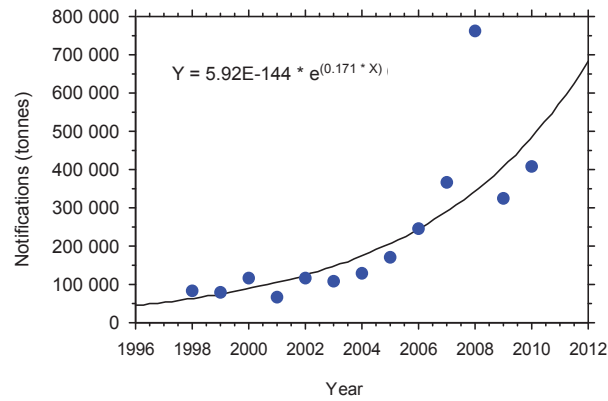


Figure 9: Notifications per year since 1998. The observed increase is significant ($P < 0.001$).

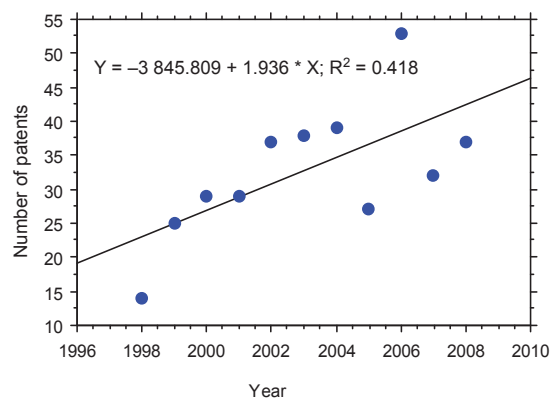


Figure 10: Number of patents lodged per year since 1998. The observed increase is significant ($P < 0.03$).