***Electronic Supplementary Material***

**Title:** Increases and decreases in marine disease reports in an era of global change

**Authors:** Allison M. Tracy, Madeline L. Pielmeier, Reyn M. Yoshioka, Scott F. Heron, C. Drew Harvell

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**Methods**

1. Web of Science Details

Taxon searches were refined by excluding irrelevant “Research Areas” (e.g. Government Law, Energy Fuels, Sports Sciences, or Business Economics) and including relevant “Document Types” (i.e., Article, Meeting, Book, Letter, Editorial, News, Report, Data Study, Case Report, Report, Data Set, Thesis Dissertation, Unspecified, and Other). Disease searches, which combined the relevant taxonomic string with the disease string, were refined only by including relevant “Document Types” and not by excluding irrelevant “Research Areas” because publications can be tagged with numerous “Research Areas” in Web of Science and we found that by excluding some areas of research, relevant publications were excluded from the results.

**Table S1.** Search strings used in Web of Science: Italics represent the search strings in both Ward and Lafferty 2004 (hereafter WL04) and this study, bold text represents additions in this study only, and strikethroughs indicate terms eliminated in this study.

**Taxonomic Group Search String**

**Or Disease String**

|  |  |
| --- | --- |
| **Corals** | *(coral\* ~~or reef\*~~)* |
| **Decapods** | *(crab\* or lobster\* or shrimp\* or prawn\*)* not (**crabro or CRABPII** or *crabgrass or Fallicambarus or Oroconectes or Procambarus or Dexteria or Eubranchipus or Streptocephalus or Gammarus or Cambarus or Mysis or Astracopsis or Macrobrachium or Coenobita or Birgus or Eriocheir or Gecarcinus or Epigrapsus or Aegla or Cardisoma or Paratya or Parannephrops or freshwater or fresh-water or (fresh and water))* |
| **Echinoderms** | *(echinoderm\* or urchin\* or seastar\* or (sea and star\*) or starfish\* or (star and fish\*) or brittlestar\* or (brittle and star\*) or ophiuroid\* or seacucumber\* or (sea and cucumber\*) or asteroid\* or echinoid\* or holothuroid\* or crinoid\*))* |
| **Fish** | *(albacore\* or amberjack\* or anchov\* or wreckfish\* or bass\* or blackfish\* or bluefish\* or burbot\* or hake\* or catfish\* or cod\* or haddock\* or (dolphin\* and fish) or drum\* or croaker\* or flounder\* or halibut\* or turbot\* or grouper\* or psettodid\* or gag\* or (sea and bass) or perch\* or rockfish\* or pilchard\* or pollock\* or polluck\* or sablefish\* or salmon\* or sardine\* or shad\* or scup\* or snapper\* or sole\* or swordfish\* or marlin\* or spearfish\* or sailfish\* or tilefish\* or tuna\* or mackerel\*)* **not (salmonella or salmonellosis)** *not (coding or code\* or codime\* or codium or codon\*) not (freshwater or (fresh and water) or fresh-water)* **not (bassoon) not (basse) not (soleus) not (tunab\*) not (shadow\* or shading or shade) not (salmonis) not (perchl\*) not (codling) not (solenoid)** |
| **Mammals** | *(whale\* or pinniped\* or seal\* or dolphin\* or cetacean\* or sealion\* or (sea and otter\*) or* **(sea and lion\*) or (enhydra and lutris)** *or manatee\*)* *not (sealant\* or sealed or sealer\*))* |
| **Molluscs** | *(mussel\* or oyster\* or clam\* or quahog\* or scallop\* or abalone\* or squid\* or cuttlefish\* or octopus\* or conch\* or nautilus\* or snail\* or limpet\* or chiton\* or caudofoveat\* or aplacophora\* or monoplacophora\* or slug\* or scaphopod\* or nudibranch\* or cockle\* or piddock\* or tusk\*) not (freshwater or (fresh and water) or fresh-water or land or terrestrial)* |
| **Seagrasses** | *(seagrass\* or sea-grass\* or (eel and grass\*) or (turtle and grass\*) or (shoal and grass\*) or (manatee and grass\*) or Zostera or Phyllospadix or Heterozostera or Posidonia or Halodule or Cymodocea or Syringodium or Amphibolis or Thalassodendron or Enhalus or Thalassia or Halophila))* |
| **Sharks & Rays** | *(dogfish\* or skate\* or shark\* or ray\* or stingray\* or whipray\* or chimaera\* or ratfish\* or (saw and fish) or (guitar and fish)) not (freshwater or Disceus or Potamotrygon or x-ray\* or raynaud\*))*  |
| **Turtles** | *(Loggerhead\* or Green or Leatherback\* or Flatback\* or Hawksbill\* or (Kemp and Ridley) or (Olive and Ridley)) and turtle\*)* |
| **Urchins** | *(urchin\*)* |
| **Disease String** | *(disease\* or parasit\* or pathogen\* or infect\* or bleaching\* or* **prevalen\*** *or virus\* or bacteri\* or viral or fung\* or nematod\* or cestod\* or trematod\* or acanthoceph\* or ectoparasit\* or endoparasit\* or worm\* or protozoa\* or protist\* or myco\* or chytrid\* or epizoot\* or vibrio\* or (mass and mortalit\*))* |
| **Raccoon** | *(raccoon\* or (Procyon and lotor) not (raccoon and dog))* |
| **Rabies Disease String** | *(raccoon\* or (Procyon and lotor) not (raccoon and dog)) and (rabies or lyssavirus)* |

1. Common Authors

We analyzed corals, elasmobranchs and molluscs to compare the results with and without the most common author, as in WL04. Excluding the most common author did not change the result, except for molluscs where the trend in the original data was marginally significant beforehand (**Table S2**). However, no author was extremely prolific relative to the total number of papers for that time period (**Table S3**).

**Table S2**.Results of analyses to check for bias from common authors for corals, elasmobranchs and molluscs

|  |  |  |
| --- | --- | --- |
| **Taxon**  | **Spearman’s rho and corrected p-value: All results** | **Spearman’s rho and corrected p-value: Most common author removed** |
| Corals | R= 0.51, P= 0.32 | R= 0.65, P= 0.11 |
| Elasmobranchs | R= -0.28, P= 0.51 | R= -0.43, P= 0.44 |
| Molluscs, 1 common author (4 papers) | R= -0.69, P= 0.089 | R= -0.88, P= 1.9e-04\* |

**Table S3**. Metrics of prolific authors in corals, elasmobranchs and molluscs

|  |  |  |  |
| --- | --- | --- | --- |
| **Taxon** | **# Papers by most prolific author** | **Total # of papers** | **% of papers by most common author** |
| Corals | 7 | 97 | 7.2% |
| Elasmobranchs | 4 (two with 4 each, both removed) | 44 | 9.1% (18.2% for both authors) |
| Molluscs | 4 | 48 | 8.3% |

1. Repeat Disease Reports

Removing repeat reports of the same disease event (based on the same location, species and disease reported) for corals as a test case did not change the direction nor substantially modify the significance of the trends for 2001-2013 or 1970-2013 (**Table S4**).

**Table S4**. Results of analyses to check for bias from repeat reports of disease in corals

|  |  |  |
| --- | --- | --- |
| **Time period** | **Spearman’s rho and corrected p-value: Original** | **Spearman’s rho and corrected p-value: Repeat disease reports removed** |
| 2001-2013 | R= 0.51, P= 0.32 | R= 0.52, P= 0.31 |
| 1970-2013 | R= 0.55, P= 0.00064 | R= 0.475, P= 0.0067 |

1. 3-year Running Mean

We determined that using a 3-year time lag was justified by calculating the average number of years between the year of a disease report and the year of publication for all disease reports in all taxa (**Table S5**). This supported the use of a 3-year sliding window for the analyses of change over time.

**Table S5**. Average time lag between disease report and year of publication for all taxa

|  |  |
| --- | --- |
| **Taxon** | **Time lag of disease reports 2001-2015** |
| Mammals | 3.7 |
| Fish | 3.6 |
| Corals | 2.8 |
| Urchins | 2.7 |
| Echinoderms | 2.7 |
| Seagrasses | 2.3 |
| Turtles | 2.6 |
| Rabies | 3.5 |
| Decapods | 3.7 |
| Elasmobranchs | 3.5 |
| Molluscs | 3.2 |
| **Average** | **3.1 (SD = 0.51)** |

1. Titles vs. Abstract Searches

We read abstracts for disease searches from 2001-2015 to determine whether literature reports of disease were truly reports of disease in a natural setting, as many are difficult to determine from the title alone. Given that WL04 used only titles in their searches, we conducted an analysis to support this departure. We first compared the results for corals for the literature proxy using only titles (“T”) to judge reports of disease vs. titles AND abstracts (“T+A”). The “T” and “T+A” analyses produced the same non-significant result for 2001-2013 and the same significant increase from 1970-2013 (**Table S6**). We then conducted the same analysis in fish, a taxon in which disease reports decreased both from 2001-2013 and from 1970-2013. Both the “T” and “T+A” analyses captured these significant decreases. The results were all calculated using the 3-year running mean, as was done in both WL04 and our analyses.

**Table S6**. Results of analyses to check for bias from using titles or titles + abstracts in corals. P values reported are raw values of analyses without Bonferonni correction.

 **Taxon** **Method 2001-2013 result 1970-2013 result**

 Corals Titles + Abstracts rho= 0.51, p= 0.081 rho= 0.55, p= 1.1E-04

 Titles rho= 0.54, p= 0.058 rho= 0.63, p= 1.1E-06

 Fish Titles + Abstracts rho=-0.85, p= 3.4E-04 rho=-0.66, p= 2.0E-06

 Titles rho=-0.61, p= 0.030 rho=-0.69, p= 6.7E-07

**Figure S1**: Analyses using titles vs. titles + abstracts for 2001-2013 and 1970-2013 do not substantially change the results for (A) taxa with increasing trends (e.g. corals) or (B) taxa with decreasing trends (e.g. fish). Searches based on titles alone are shown in green while searches that include reading abstracts are shown in red. WL04 used titles alone because abstracts were infrequently available for older records.

(A) Corals



(B) Fish



**Results**

**Figure S2**: Confidence intervals based on successes and total experiments using the “confint” function in the R package “binom”. The value on the vertical axis is the percent of total reports per taxon per year that reported disease.



**Figure S3**: (A) The sum of normalized disease reports from 1970-2013 illustrates that fish and decapods have the most reports of disease when accounting for research effort. Meanwhile, urchins, seagrass, corals and molluscs have the fewest total disease reports. (B) Comparing the total number of disease reports without normalizing for research effort (i.e. as in (A), by dividing by the number of taxon results) greatly skews the disease report metric in favor of more well-studied, commercially important taxa: fish, molluscs, and decapods have the greatest number of disease reports without normalization. Error bars denote +/- 1 standard deviation.

­
(A)



(B)

