

Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our [Editorial Policies](#) and the [Editorial Policy Checklist](#).

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a Confirmed

- | | | |
|-------------------------------------|-------------------------------------|--|
| ☐ | ☒ | The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement |
| ☐ | ☒ | A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly |
| ☐ | ☒ | The statistical test(s) used AND whether they are one- or two-sided
<i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i> |
| ☐ | ☒ | A description of all covariates tested |
| ☐ | ☒ | A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons |
| ☐ | ☒ | A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals) |
| ☐ | ☒ | For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted
<i>Give P values as exact values whenever suitable.</i> |
| ☒ | ☐ | For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings |
| ☒ | ☐ | For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes |
| ☐ | ☒ | Estimates of effect sizes (e.g. Cohen's d , Pearson's r), indicating how they were calculated |

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection	microbiome software used for data processing and collection: Qiita 2022.07, Qiime2-2022.2, Deblur v1.1.0
Data analysis	microbiome software used for data analysis: Qiita 2022.07, Qiime2-2022.2, Deblur v1.1.0, Prism 9.4.1; Qiita analysis ID 49571, github.com/jminich444/Fish_Microbiome_Project;

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

This statement is in the manuscript. Also it is here EBI ERP139587; Qiita study ID 13414; fishbase.org used to gather life history information on fishes

Human research participants

Policy information about [studies involving human research participants and Sex and Gender in Research.](#)

Reporting on sex and gender	N/A
Population characteristics	N/A
Recruitment	N/A
Ethics oversight	N/A

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	This was a microbiome study (16S) of four body sites from 101 different species of wild marine fish. There were also additional species from the Atlantic.
Research sample	All details are in the supplemental data set "fmp_metadata": <i>Paralabrax clathratus</i> <i>Caulolatilus princeps</i> <i>Sebastes umbrosus</i> <i>Sebastes constellatus</i> <i>Sebastes carnatus</i> <i>Sebastes mystinus</i> <i>Phanerodon furcatus</i> <i>Halichoeres californicus</i> <i>Embiotoca jacksoni</i> <i>Anisotremus davidsonii</i> <i>Sphyræna argentea</i> <i>Paralabrax nebulifer</i> <i>Seriphus politus</i> <i>Mustelus californicus</i> <i>Triakis semifasciata</i> <i>Leptocottus armatus</i> <i>Sebastes serriceps</i> <i>Semicossyphus pulcher</i> <i>Atherinopsis californiensis</i> <i>Trachurus symmetricus</i> <i>Kyphosus azureus</i> <i>Girella nigricans</i> <i>Heterostichus rostratus</i> <i>Oxyjulis californica</i> <i>Syngnathus leptorhynchus</i> <i>Citharichthys xanhostigma</i> <i>Sebastes dallii</i> <i>Sebastes miniatus</i> <i>Sebastes semicinctus</i> <i>Menticirrhus undulatus</i> <i>Myliobatis californica</i> <i>Heterodontus francisci</i> <i>Gibbonsia elegans</i> <i>Hypsoblennius gilberti</i> <i>Paralabrax maculatofasciatus</i> <i>Chromis punctipinnis</i>

Paralichthys californicus
 Sebastes hopkinsi
 Sebastes chlorostictus
 Engraulis mordax
 Scorpaena guttata
 Sebastes auriculatus
 Symphurus atricaudus
 Umbrina roncadore
 Brachygenys californiensis
 Roncadore stearnsii
 Urobatis halleri
 Porichthys myriaster
 Cynoscion parvipinnis
 Albula gilberti
 Synodus lucioceps
 Rhacochilus toxotes
 Brachyistius frenatus
 Medialuna californiensis
 Notorynchus cepedianus
 Sarda chiliensis
 Alopias vulpinus
 Sardinops sagax
 Triphoturus mexicanus
 Lyopsetta exilis
 Sebastes diploproa
 Physiculus rastrelliger
 Microstomus pacificus
 Glyptocephalus zachirus
 Gymnura marmorata
 Gymnothorax mordax
 Xeneretmus latifrons
 Lipolagus ochotensis
 Citharichthys sordidus
 Porichthys notatus
 Parophrys vetulus
 Merluccius productus
 Lycodes cortezianus
 Lyconema barbatum
 Leuroglossus stilbius
 Nemichthys scolopaceus
 Seriola dorsalis
 Pteroplatytrygon violacea
 Eptatretus stoutii
 Lycodes diapterus
 Stomias atriventer
 Apristurus brunneus
 Lycodes pacificus
 Facciolella equatorialis
 Scopelogadus (mizolepis) bispinosus
 not applicablenobranchium ritteri
 Sternopyx pseudobscura
 Argyropelecus affinis
 Ceratoscopelus townsendi
 Stereolepis gigas
 Nezumia stelgidolepis
 Thunnus albacares
 Clevelandia ios
 Fundulus parvipinnis
 Coryphaena hippurus
 Katsuwonus pelamis
 Atherinops affinis
 Gillichthys mirabilis
 Pleuronichthys guttulatus
 Cheilotrema saturnum
 Scomber japonicus
 Paralichthys dentatus
 Prionotus carolinus
 Centropristis striata

	Bairdiella chrysoura Fundulus heteroclitus Brevoortia tyrannus Chasmodes bosquianus Strongylura marina Opsanus tau Anguilla rostrata Caranx crysos Coryphaena hippurus Lucania parva Leucoraja erinacea Thunnus albacares Pomatomus saltatrix Morone saxatilis
Sampling strategy	Wild fish were collected using the scientific research permit of the corresponding author. Also bycatch from other scientific collections were included. Lastly, some freshly dead fish were donated by recreational fishers. 1 fish per species was collected.
Data collection	Samples were collected and data on species type, location, time recorded immediately. Other data on mass, length, gape size, etc. were collected during the dissections. Data was collected by pen and paper and then transferred to google sheets.
Timing and spatial scale	Fish were collection opportunistically across a few years from 2018-2020. Most fish were from Southern California (San Diego area). Various groups or cohorts of fish were collected during targeted surveys such as the bottom trawl surveys conducted on the SIO research vessels.
Data exclusions	We use a very specific sample exclusion methodology based on the read counts for each sample compared to known positive controls. This is detailed in the paper. In fact, this exclusion criteria methodology is one of the primary methods developed in this paper. See the methods and qiime2 plugin katharoseq for more detail.
Reproducibility	All data is available and we have done our best to make it all public. In this instance we were collecting wild animals. One will never be able to go back in time to collect those exact animals from the exact locations so in some regards one could consider this a natural observation type of study. One could however collect the same species at a later time point to try and reproduce the findings.
Randomization	For sample processing, all species were randomized on each extraction plate but were processed generally by sample type
Blinding	Is it not possible to do blind analyses as we were looking at how different factors influence the fish microbiome community
Did the study involve field work?	☒ Yes ☐ No

Field work, collection and transport

Field conditions	Samples were collected from either small craft, research vessels, fishing from a fixed object (pier), or from spearfishing/kayaking. All sampling were conducted in safe conditions. No samples were collected during the rain. We do not have air temperatures for when samples were collected but generally speaking it would have been between 50-80 F.
Location	All exact lat/long details and depth etc are in the metadata files. Samples were collected from the EEZ of San Diego, CA or from NY New York. hhost_scientific_name depth_m latitude longitude Paralabrax clathratus 3 32.848152 -117.278413 Caulolatilus princeps 10 32.854483 -117.273919 Sebastes umbrosus 30 32.83399 -117.30876 Sebastes constellatus 30 32.83399 -117.30876 Sebastes carnatus 30 32.83399 -117.30876 Sebastes mystinus 30 32.83399 -117.30876 Phanerodon furcatus 3 33.113536 -117.325634 Halichoeres californicus 3 33.113536 -117.325634 Embiotoca jacksoni 3 33.113536 -117.325634 Anisotremus davidsonii 3 33.113536 -117.325634 Sphyræna argentea 2 32.80081 -117.269514 Paralabrax nebulifer 2 32.80081 -117.269514 Seriphys politus 2 32.80081 -117.269514 Mustelus californicus 3 32.788406 -117.246274 Triakis semifasciata 3 32.770985 -117.242299 Leptocottus armatus 1 32.841184 -117.281972 Sebastes serriceps 30 32.83399 -117.30876 Semicossyphus pulcher 30 32.83399 -117.30876 Atherinopsis californiensis 5 32.858496 -117.276143

Trachurus symmetricus 5 32.858496 -117.276143
 Kyphosus azureus 3 32.832233 -117.28381
 Girella nigricans 3 32.832233 -117.28381
 Heterostichus rostratus 3 32.832233 -117.28381
 Oxyjulis californica 3 32.832233 -117.28381
 Syngnathus leptorhynchus 1 32.867124 -117.257229
 Citharichthys xanthostigma 35 32.961121 -117.302943
 Sebastes dallii 35 32.961121 -117.302943
 Sebastes miniatus 35 32.961121 -117.302943
 Sebastes semicinctus 35 32.961121 -117.302943
 Menticirrhus undulatus 1 33.113536 -117.325634
 Myliobatis californica 1 33.113536 -117.325634
 Heterodontus francisci 4 32.75757 -117.249448
 Gibbonsia elegans 1 32.841184 -117.281972
 Hypsoblenius gilberti 1 32.841184 -117.281972
 Paralabrax maculatofasciatus 3 32.760464 -117.245347
 Chromis punctipinnis 3 32.760464 -117.245347
 Paralichthys californicus 3 32.776937 -117.243164
 Sebastes hopkinsi 50 32.709444 -117.3125
 Sebastes chlorostictus 50 32.708889 -117.299722
 Engraulis mordax 5 32.762464 -117.239009
 Scorpaena guttata 30 33.142589 -117.378686
 Sebastes auriculatus 30 33.126629 -117.374183
 Symphurus atricaudus 3 32.789026 -117.24557
 Umbrina roncadorensis 3 32.772748 -117.229627
 Brachygenys californiensis 3 32.772748 -117.229627
 Roncadorensis stearnsi 3 32.772748 -117.229627
 Urobatis halleri 3 32.789805 -117.248309
 Porichthys myriaster 3 32.776937 -117.243164
 Cynoscion parvipinnis 3 32.658399 -117.232094
 Albula gilberti 3 32.658399 -117.232094
 Synodus lucioceps 3 32.769349 -117.227735
 Rhacochilus toxotes 6 32.830845 -117.294357
 Brachyistius frenatus 6 32.830845 -117.294357
 Medialuna californiensis 6 32.830845 -117.294357
 Notorynchus cepedianus 6 32.841484 -117.297446
 Sarda chiliensis 3 32.867124 -117.257229
 Alopias vulpinus 3 32.789805 -117.248309
 Sardinops sagax 3 32.867124 -117.257229
 Triphoturus mexicanus 300 32.674701 -117.355389
 Lyopsetta exilis 300 32.674701 -117.355389
 Sebastes diploproa 300 32.674701 -117.355389
 Physiculus rastrelliger 300 32.674701 -117.355389
 Microstomus pacificus 300 32.674701 -117.355389
 Glyptocephalus zachirus 300 32.674701 -117.355389
 Gymnura marmorata 1 32.769915 -117.248336
 Gymnothorax mordax 1 32.763155 -117.241393
 Xeneretmus latifrons 150 32.63861111 -117.3416667
 Lipolagus ochotensis 500 32.70094444 -117.5519444
 Citharichthys sordidus 150 32.63861111 -117.3416667
 Porichthys notatus 150 32.63861111 -117.3416667
 Parophrys vetulus 150 32.63861111 -117.3416667
 Merluccius productus 328.5 32.68916667 -117.3844444
 Lycodes corteziensis 328.5 32.68916667 -117.3844444
 Lyconema barbatum 328.5 32.68916667 -117.3844444
 Leuroglossus stilbius 328.5 32.68916667 -117.3844444
 Nemichthys scolopaceus 500 32.70094444 -117.5519444
 Seriola dorsalis 10 33.098027 -117.374053
 Pteroplatytrygon violacea 3 33.098027 -117.374053
 Eptatretus stoutii 300 32.674701 -117.355389
 Lycodes diapterus 300 32.674701 -117.355389
 Stomias atriventer 500 32.674701 -117.355389
 Apristurus brunneus 500 32.674701 -117.355389
 Lycodes pacificus 500 32.674701 -117.355389
 Facciolella equatorialis 500 32.674701 -117.355389
 Scopelogadus (mizolepis) bispinosus 500 32.674701 -117.355389
 not applicablenobranchium ritteri 500 32.674701 -117.355389
 Sternoptyx pseudobscura 500 32.70094444 -117.5519444

Argyrolepecus affinis 500 32.70094444 -117.5519444
 Ceratoscopelus townsendi 500 32.70094444 -117.5519444
 Stereolepis gigas 10 32.861218 -117.274588
 Nezumia stelgidolepis 500 32.674701 -117.355389
 Thunnus albacares 1 32.091667 -118.208333
 Clevelandia ios 1 32.769594 -117.248478
 Fundulus parvipinnis 1 32.782075 -117.250127
 Coryphaena hippurus 3 32.616069 -117.396926
 Katsuwonus pelamis 3 31.435833 -117.420556
 Atherinops affinis 1 32.787057 -117.208794
 Gillichthys mirabilis 1 32.787057 -117.208794
 Pleuronichthys guttulatus 1 32.769594 -117.248478
 Cheilotrema saturnum 2 32.748242 -117.255313
 Scomber japonicus 1 32.867124 -117.257229
 Paralichthys dentatus 30 40.545278 -73.046028
 Prionotus carolinus 24 40.559667 -73.037444
 Centropristis striata 30 40.546278 -73.045222
 Bairdiella chrysoura 1 40.664722 -73.383187
 Fundulus heteroclitus 0.5 40.664722 -73.383187
 Brevoortia tyrannus 2 40.664722 -73.383187
 Chasmodes bosquianus 1 40.664722 -73.383187
 Strongylura marina 2 40.664722 -73.383187
 Opsanus tau 1 40.664722 -73.383187
 Anguilla rostrata 1 40.664722 -73.383187
 Caranx crysos 38 40.250278 -73.164167
 Coryphaena hippurus 38 40.265722 -73.223
 Lucania parva 0.5 40.664722 -73.383187
 Leucoraja erinacea 22 40.539722 -73.041111
 Thunnus albacares 152 39.524611 -72.207806
 Pomatomus saltatrix 17.2 40.628217 -73.29205
 Morone saxatilis 3 40.664722 -73.383187

Access & import/export

All samples were collected under permit or donated from fishers from US locations

Disturbance

No impact

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☐	☒ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Animals and other research organisms

Policy information about [studies involving animals](#); [ARRIVE guidelines](#) recommended for reporting animal research, and [Sex and Gender in Research](#)

Laboratory animals

No lab animals were used in the study

Wild animals

Wild fish were caught using a variety of methods including trawl, hook and line, spear, and gillnet. They were immediately euthanized using the approved procedure of ikejime. Fishes which were caught from bycatch (moribund) were also euthanized this way if they were not already deceased. Most fishes one cannot know the age although we can say that most if not all of our fish were in the juvenile to adult range but not larval.

Reporting on sex	For the most part, we did not identify sex. Where we did it is in the metadata.
Field-collected samples	all samples were from the field (wild)
Ethics oversight	All animals were handled and euthanized ethically according to the universities guidelines. For collection, we used a 2016 scientific collecting permit DFW 1379: DocID: D-0018712881-8

Note that full information on the approval of the study protocol must also be provided in the manuscript.