Petition to List Bull Kelp under the U.S. Endangered Species Act

Photo Credit: Steve Lonhart / NOAA MBNMS

Center for Biological Diversity

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Dear Secretary of Commerce,

Pursuant to the Endangered Species Act ("ESA"), 16 U.S.C. § 1533(b), the Center for Biological Diversity formally petitions the Secretary of Commerce to list the bull kelp (*Nereocystis leutkeana*) as an endangered or threatened species and to designate critical habitat concurrent with the listing.

The Secretary of Commerce and the National Marine Fisheries Service ("NMFS"), an agency within the National Oceanic and Atmospheric Administration ("NOAA"), have jurisdiction over this Petition. This Petition sets in motion a specific process, requiring NMFS to make an initial finding as to whether the Petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533(b)(3)(A). NMFS must make this initial finding "[t]o the maximum extent practicable, within 90 days after receiving the petition." Id. Petitioner does not need to demonstrate that the listing is warranted, but rather that the information presented demonstrates that such action may be warranted. Petitioners believe the best available scientific information demonstrates that listing the bull kelp as endangered is warranted, and the available information clearly indicates that listing the species may be warranted. Therefore, NMFS must promptly make a positive finding on the Petition and commence a status review, as required by 16 U.S.C. § 1533(b)(3)(B).

NMFS must acknowledge the receipt of this Petition within a reasonable timeframe. 50 C.F.R. § 424.14(f)(2). A hard copy of this petition and thumb drive with all cited references will be mailed to you via the U.S. Postal Service.

If you have any questions, please feel free to contact us via the information contained in the signature blocks below.

Sincerely,

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Legal and Regulatory Framework

The Center for Biological Diversity formally petitions the Secretary of Commerce (Secretary), acting through the National Marine Fisheries Service (NMFS), an agency within the National Oceanic and Atmospheric Administration (NOAA), to list the bull kelp (*Nereocystis leutkeana*) as endangered under the U.S. Endangered Species Act (ESA) and to designate critical habitat for the species within U.S. waters. See 16 U.S.C. §§ 1531–1544.

This Petition is submitted pursuant to the ESA, 16 U.S.C. § 1533(b)(3)(A), the ESA's implementing regulations, 50 C.F.R. § 424.14, and the Administrative Procedure Act, 5 U.S.C. § 553(e). In keeping with 50 C.F.R. § 424.14(f)(2), NMFS must acknowledge the receipt of this Petition within a reasonable timeframe. As fully set forth below, this Petition contains all the information requested in 50 C.F.R. § 424.14(c)–(e) and 16 U.S.C. § 1533(e). All cited documents are listed in the References section; electronic copies of these documents accompany this petition and pinpoint citations to these have been provided where appropriate. See 50 C.F.R. § 424.14(c)(5)–(6).

In reviewing the bull kelp's status, NMFS must analyze whether the species warrants listing throughout all or a significant portion of its range. 16 U.S.C. § 1532(6), (20). If NMFS proposes to list the bull kelp as threatened, Petitioners ask that the agency promulgate a final 4(d) rule to confer full take protections on the species concurrent with a final listing. See 16 U.S.C. § 1533(d). Those protections are necessary and advisable to provide for the conservation of the species. Further, if the bull kelp is listed as endangered or threatened, Petitioners ask that NMFS promulgate a 4(e) rule for species similar in appearance to the bull kelp. As set forth in 50 C.F.R. § 424.14(j), "[t]he Services will conduct a review of petitions to . . . adopt a rule under section 4(d) [or] 4(e) . . . of the [ESA] in accordance with the Administrative Procedure Act (5 U.S.C. [§] 553) and applicable Departmental regulations, and take appropriate action."

Under the ESA, a species is "endangered" if it is "in danger of extinction throughout all or a significant portion of its range" due to one or more of the five listing factors. 16 U.S.C. § 1531(6). A species is "threatened" if it is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." 16 U.S.C. § 1531(20). The agency's review and determination must be based on the best scientific and commercial data available. 16 U.S.C. § 1533(b)(1)(A). This requirement aims to "ensure that the ESA not be implemented haphazardly, on the basis of speculation or surmise." *Bennett v. Spear*, 117 S.Ct. 1154, 1168 (1997).

Listing may be done at the initiative of the Secretary or in response to a petition. 16 U.S.C. § 1533(b)(3)(A). After receiving a petition to list a species, the Secretary is required to determine "whether the petition presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533(b)(3)(A). A "positive" 90-day finding leads to a status review and a determination of whether the species will be listed, to be completed within twelve months. 16 U.S.C. §1533(b)(3)(B). A "negative" initial finding ends the listing process, and the ESA authorizes judicial review of such a finding. 16 U.S.C. § 1533(b)(3)(C)(ii).

"Substantial information" is defined as the "amount of information that would lead a reasonable person to believe that the measure proposed in the petition may be warranted." 50 C.F.R. § 424.14(b)(1). The four factors to guide the Service's consideration on whether a particular listing petition provides "substantial" information include:

a. Clearly indicates the administrative measure recommended and gives the scientific and any common name of the species involved;
b. Contains detailed narrative justification for the recommended measure; describing, based on available information, past and present numbers and distribution of the species involved and any threats faced by the species;
c. Provides information regarding the status of the species over all or significant portion of its range; and
d. Is accompanied by appropriate supporting documentation in the form of bibliographic references, reprints of pertinent publications, copies of reports or letters from authorities, and maps.

50 C.F.R. § 424.14(b)(2)(i)-(iv).

The ESA does not require "conclusive evidence of a high probability of species extinction" in order to support a positive 90-day finding. *Ctr. for Biological Diversity v. Morgenweck*, 351 F.Supp.2d 1137, 1140 (D. Colo. 2004). Rather, the ESA contemplates a "lesser standard by which a petitioner must simply show that the substantial information in the Petition demonstrates that listing of the species may be warranted." *Morgenweck*, 351 F.Supp.2d at 1141.

Executive Summary

The Center for Biological Diversity submits this petition to list the bull kelp (*Nereocystis leutkeana*) as a threatened or endangered species pursuant to the Endangered Species Act ("ESA"). This petition demonstrates that the bull kelp is eligible for and warrants listing under the ESA based on the best scientific information, in the context of the five listing factors specified in the statute.

Nereocystis leutkeana is a large, brown, annual algae in the kelp order (Laminariales). The species' range stretches from Point Conception, California to Unimak Island, Alaska. It grows on rocky substrates in shallow coastal waters, between 3 and 20 meters in depth. In the southern part of its range, bull kelp are known to overlap with giant kelp (*Macrocystis pyrifera*). When they overlap, bull kelp fill the more exposed parts of the ecosystem. However, bull kelp are the dominant species of kelp north of Año Nuevo, California. Bull kelp is a foundation species that provides habitat for fish, invertebrates, and sea otters, in addition to being a culturally significant to indigenous and contemporary coastal communities.

Recent scientific literature has shed light on alarming declines in bull kelp populations throughout the species' range. Bull kelp are in peril due to several anthropogenic threats: climate change, thermal pollution, heavy metal pollution, coastal darkening, and oil spills. After the 2014 marine heat wave, bull kelp populations decreased by 90% along the coasts of Mendocino and Sonoma counties. The 2014 marine heat wave was followed by one of the most extreme El Niño events in recorded history. Bull kelp have yet to recover to pre-2014 levels, and this is the longest bull kelp have gone without recovering in 38 years. There is also evidence that bull kelp populations decrease in coastal areas near high human activity. Thermal pollution from power plants can locally increase water temperatures, and bull kelp are thermally sensitive. Additionally, heavy metals from factories and oil from oil spills can poison bull kelp, and increased turbidity from runoff can block light to the algae.

Natural threats to bull kelp have also been exacerbated by human activity. Because of climate change induced extreme heat events, kelp forests are being transformed into urchin barrens. Purple sea urchins are natural predators of bull kelp. Urchins can take over areas that used to be kelp beds after kelp die off from heat. Extreme temperatures have also caused mass die-offs of sunflower sea stars, a sea urchin predator. Another sea urchin predator, the southern sea otter, was extirpated throughout much of its range in 18th and 19th centuries for the fur trade. It has only recolonized approximately 13% of its former range. With fewer natural predators to keep them in check, sea urchins can overgraze bull kelp and greatly decrease bull kelp populations.

There are no existing regulatory mechanisms that are sufficient to protect this algae from extinction. Although some bull kelp habitat is protected by National Marine Sanctuaries, these sanctuaries have so far failed to prevent population declines. Furthermore, the National Marine Sanctuaries only protect the southernmost part of the bull kelp habitat range. There are no National Marine Sanctuaries in Washington or Alaska, where bull kelp are the dominant canopy-building kelp species. Listing of the bull kelp as a threatened or endangered species and designating critical habitat under the ESA is necessary to provide critical legal protections to ensure the survival of this highly imperiled algae species.

Given bull kelp's recent population declines and known threats, including climate change and coastal development, listing the species as threatened or endangered under the ESA clearly is warranted. The

appropriate classification can be determined following the completion of the National Marine Fisheries Service Species Status Assessment and following public notice and comment.

PART I. SPECIES ACCOUNT

INTRODUCTION AND SPECIES DESCRIPTION

Kelp, scientifically known as members of the order Laminariales, are found in coastal rocky reefs in temperate oceans around the world. Laminariales live in 43% of all the marine ecoregions in the world and have historically been found along the coast of every continent except Antarctica.[1] Bull kelp (*Nereocystis luetkeana*) is a type of Laminariales that lives exclusively along the western coast of North America. Bull kelp is considered a foundation species, which Paul Dayton first defined in 1972 to describe species that play an important in providing structure to a community.[2] Animals like sea otters[3] and salmon[4] depend on kelp forests for habitat. It also provides ecosystem services[5] like reducing wave strength near the shore,[6] decreasing coastal erosion,[7] and providing a high rate of primary productivity.[8] Furthermore, healthy bull kelp canopies support economically important fisheries: in 2017, kelp declines led to 80% mortality of abalone, causing the closure of the recreational abalone fishery and a loss of $44 million.[9] Bull kelp is culturally significant to coastal communities, where kelp has long played an important role in recreational fishing, scuba diving, and kayaking.[10] This large, ecologically critical brown

[1] Spalding, M., et al., Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas, 57 BioScience 573 (2007); Krumhansl, K., et al., Global patterns of kelp forest change over the past half-century, 113 Proceedings of the National Academy of Sciences 13785 (2016)

[2] Dayton, P., Toward an understanding of community resilience and the potential effects of enrichments to the benthos at McMurdo Sound, Antarctica, Proceedings of the Colloquium on Conservation Problems Allen Press 81 (1972); Springer, Y., et al., Toward ecosystem-based management of marine macroalgae - the bull kelp Nereocystis luekeana, 48 Oceanography and Marine Biology An Annual Review 1 (2010); Finger, D., et al., Mapping bull kelp canopy in northern California using Landsat to enable long-term monitoring, 254 Remote Sensing of Environment 112243 (2021); Krumhansl, K., et al., Global patterns of kelp forest change over the past half-century, 113 Proceedings of the National Academy of Sciences 13785 (2016); Schroeder, S., et al., Spatial and temporal persistence of nearshore kelp beds on the west coast of British Columbia, Canada using satellite remote sensing, 6 Remote Sensing in Ecology and Conservation 327 (2019)

[3] Sanctuary Integrated Monitoring Network. Bull Kelp. Accessed August 17, 2022: https://sanctuarysimon.org/dbtools/species-database/id/75/nereocystis/luetkeana/bull-kelp/; Davis, R. W., et al., Future Directions in Sea Otter Research and Management, 5 Fronteirs in Marine Science 510 (2019)

[4] Schroeder, S. Satellite remote sensing of Nereocystis luetkeana (bull kelp) and the use of kelp by juvenile salmon in the Salish Sea, University of Victoria Department of Geography (2016)

[5] Springer, Y., et al., Toward ecosystem-based management of marine macroalgae - the bull kelp Nereocystis luekeana, 48 Oceanography and Marine Biology An Annual Review 1 (2010)

[6] Løvås & Tørum, Effect of the kelp *Laminaria hyperborea* upon sand dune erosion and water particle velocities, 44 Coastal Engineering 37 (2001)

[7] Løvås & Tørum, Effect of the kelp *Laminaria hyperborea* upon sand dune erosion and water particle velocities, 44 Coastal Engineering 37 (2001); Ronnback, P., et al., Ecosystem goods and services from swedish coastal habitats: identification, valuation, and implications of ecosystem shifts. 36 Ambio 534 (2007)

[8] Mann, K., Seaweeds: Their Productivity and Strategy for Growth. 182 Science 975 (1973)

[9] Rogers-Bennet & Catton, Marine heat wave and multiple stressors tip bull kelp forest to sea urchin barrens, 9 Nature Scientific Reports 15050 (2019)

[10] Springer et al. 2010 citing Kildow, J. & Colgan, C.S. California's Ocean Economy. Prepared for the California Resources Agency by the National Ocean Economics program, Moss landing, California (2005) Available HTTP: https://cbe.miis.edu/noep_publications/8/

macroalgae has long been a defining feature of the North American west coast, but now the species faces a multitude of anthropogenic threats warranting bull kelp's protection under the U.S. Endangered Species Act.

A. Taxonomy

Kingdom	Protists
Phylum	Ochrophyta
Class	Phaeophyceae
Order	Laminariales
Family	Lessoniaceae
Genus	*Nereocystis*
Species	*luetkeana*

See Lane, Christopher E. *et al*., A multi-gene molecular investigation of the kelp (Laminariales, Phaeophyceae) supports substantial taxonomic re-organization,42 J. Phycology 493 (2006); Stanford SeaNet, Phylum Ochrophyta, Accessed August 25, 2022: https://seanet.stanford.edu/Ochrophyta#Nereocystis

B. Physiology and Morphology

Bull kelp is an annual species, meaning it completes its lifecycle in a single growing season.[11,12] Most bull kelp live for up to nine months, but some individuals can survive for up to 18 months.[13] They grow in coastal, shallow rocky habitats where the water is between three and 20 meters deep.[14]

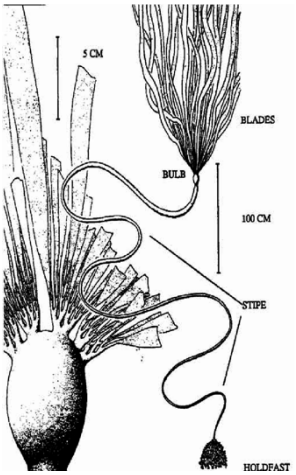

Figure 1: Diagram of a bull kelp[15]

[11] Dobkowski, K., Biotic and Abiotic Influences on Bull Kelp (Nereocystis luetkeana) Abundance and Distribution in the Salish Sea, University of Washington (2017)
[12] Duggins, D., Kelp Beds and Sea Otters: An Experimental Approach, 61 The Ecological Society of America 447 (1980)
[13] *Id.*
[14] Springer, Y., et al., Toward Ecosystem-Based Management of Marine Macroalgae – The Bull Kelp, *Nereocystis luetkeana*, 48 Oceanography and marine biology 1 (2010)
[15] Springer et al. 2010 citing Smith, G.M., Marine Algae of the Monterey Peninsula, copyright © 1944 by the Board of Trustees of the Leland Stanford Jr. University, renewed 1972.

As shown in Figure 1, the bull kelp is made up of a holdfast, stipe, bulb, and blades.[16] An adult bull kelp has approximately 40 to 60 blades, which can each grow to be up to 4 meters long.[17] The top third of the stipe is hollow and very elastic, and can stretch up to 38% when experiencing force from waves.[18] All the kelp's photosynthesis and nutrient uptake is done by the blades and then distributed to the rest of the kelp.[19]

Individual bull kelp can become dislodged by storms and will then float to the beach or stay at the water's surface and form kelp rafts. Kelp on the beach provides essential nutrients to the sandy shore ecosystem, and kelp rafts create habitat for larvae and juvenile fish.[20]

HABITAT AND DISTRIBUTION

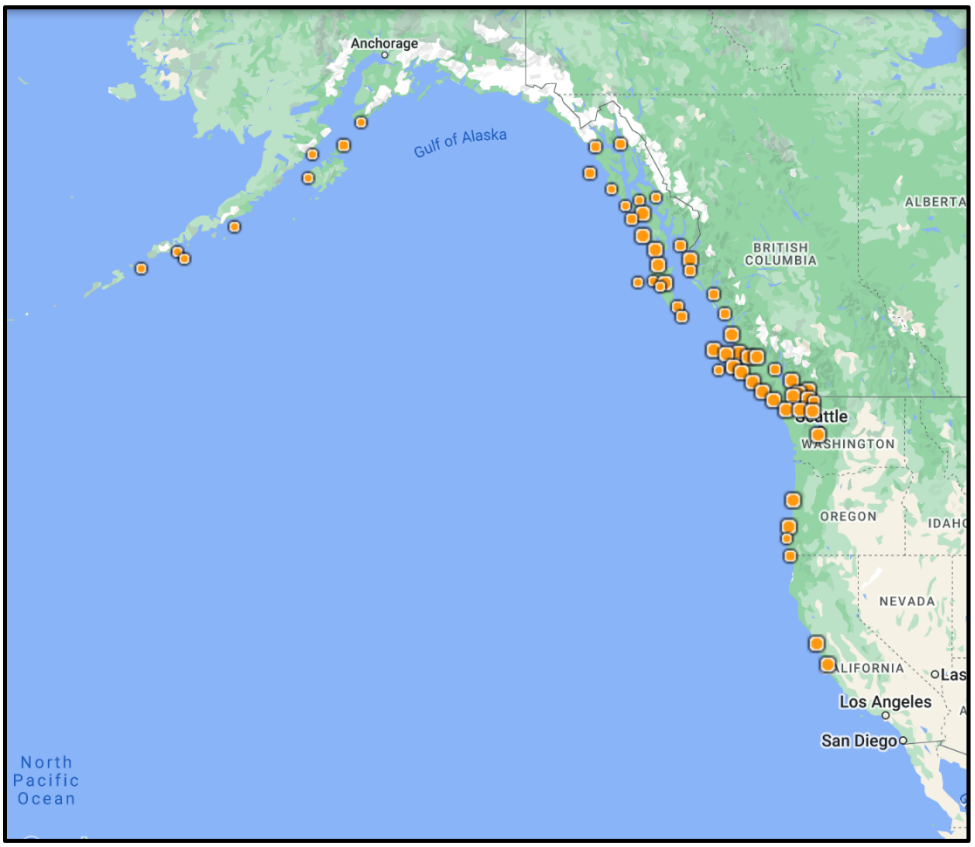

Figure 2: Map of Bull Kelp habitat range from the Consortium of Pacific Northwest Herbaria.[21]

[16] Springer, Y., et al., Toward Ecosystem-Based Management of Marine Macroalgae – The Bull Kelp, *Nereocystis luetkeana*, 48 Oceanography and marine biology 1 (2010)
[17] *Id.*
[18] *Id.*
[19] *Id.*
[20] *Id.*
[21] Consortium of Pacific Northwest Herbaria Accessed August 9, 2022: https://www.pnwherbaria.org/data/results.php?DisplayAs=WebPage&ExcludeCultivated=Y&GroupBy=ungrouped&SortBy=Year&SortOrder=DESC&SearchAllHerbaria=Y&QueryCount=1&IncludeSynonyms1=Y&Genus1=Nereocystis&Species1=luetkeana&Zoom=4&Lat=55&Lng=-135&PolygonCount=0

Bull habitat ranges along the western coast of North America from Point Conception, California to Unimak Island, Alaska.[22] Bull kelp can co-occur with other habitat-building kelp species like dragon kelp (*Eualaria fistulosa*) or giant kelp (*Macrocystis pyrifera*), but can also occur alone.[23] Giant kelp and bull kelp especially often form mixed kelp ecosystems between Año Nuevo, CA and Point Conception, CA, while north of Año Nuevo to Alaska bull kelp is the predominant kelp species.[24] When giant kelp and bull kelp co-occur, bull kelp usually fills the more exposed part of the ecosystem.[25]

Bull kelp can be found in coastal areas with turbulent water.[26] They usually grow on subtidal rocks between three and 20 meters in depth.[27] Bull kelp is a habitat-builder, and provides habitat for a variety of other organisms, including sea otters, sea stars, young fish, and abalone.[28]

REPRODUCTION AND GROWTH

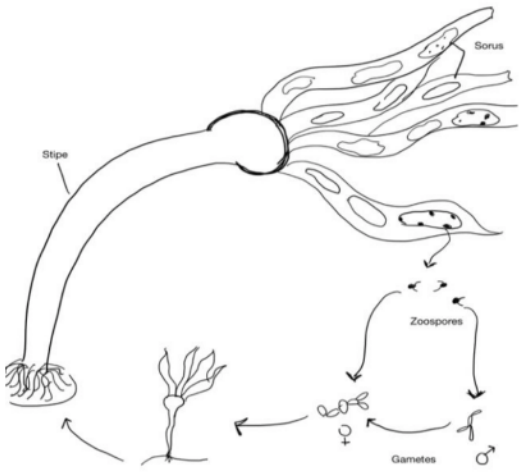

Figure 2: Diagram of *Nereocystis leutkeana* life cycle.[29]

[22] Springer, Y., et al., Toward Ecosystem-Based Management of Marine Macroalgae – The Bull Kelp, *Nereocystis luetkeana*, 48 Oceanography and marine biology 1 (2010)
[23] *Id.*
[24] *Id.*
[25] *Id.*
[26] Sanctuary Integrated Monitoring Network. Bull Kelp. Accessed August 17, 2022: https://sanctuarysimon.org/dbtools/species-database/id/75/nereocystis/luetkeana/bull-kelp/
[27] Springer, Y., et al., Toward Ecosystem-Based Management of Marine Macroalgae – The Bull Kelp, *Nereocystis luetkeana*, 48 Oceanography and marine biology 1 (2010)
[28] Sanctuary Integrated Monitoring Network. Bull Kelp. Accessed August 17, 2022: https://sanctuarysimon.org/dbtools/species-database/id/75/nereocystis/luetkeana/bull-kelp/; Rogers-Bennet & Catton, Marine heat wave and multiple stressors tip bull kelp forest to sea urchin barrens, 9 Nature Scientific Reports 15050 (2019); Schroeder, S. Satellite remote sensing of Nereocystis luetkeana (bull kelp) and the use of kelp by juvenile salmon in the Salish Sea, University of Victoria Department of Geography (2016); Davis, R. W., et al., Future Directions in Sea Otter Research and Management, 5 Fronteirs in Marine Science 510 (2019)
[29] Cullen, Ashley. Water on the Rise: Bull Kelp Gametophyte survival in rising temperatures. Friday Harbor Laboratories University of Washington (2019)

Nereocystis leutkeana is an annual large brown alga[30] that reproduces sexually.[31] As an adult, the bull kelp is called a sporophyte and has two sets of chromosomes.[32] Bull kelp usually reach maturity during the summer or fall seasons, after which it forms patches of spores, called sori, on the kelp blades.[33] The kelp sheds sori around dawn, and the sori release spores as they sink.[34] Since the sori are heavy, they sink quickly and continue to release spores even after they've reached the ocean floor.[35] While the spores are capable of photosynthesizing, they can't live independently for very long.[36]

Spores usually settle near the parent algae, but it is also possible for them to disperse further away they are released from the sori in a strong current.[37] It is generally desirable for the spores to settle near the parent algae so that they have access to a good substrate.[38] After spores settle, they develop into male or female gametophytes, and with favorable environmental conditions the gametophytes will produce gametes (sperm or eggs, respectively).[39] Gametophytes need high nutrient levels, plenty of light, and environmental temperatures to be between 5 and 15 degrees Celsius to produce gametes.[40] The odds of gametophyte fertilization increase with proximity to other gametophytes, as well as by the pheromone lamoxirene that female gametophytes release.[41] Lamoxirene increases sperm release and attracts sperm to the female gametophyte.[42]

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[30] Springer, Y., et al., Toward ecosystem-based management of marine macroalgae - the bull kelp Nereocystis luekeana, 48 Oceanography and Marine Biology An Annual Review 1 (2010)
[31] Kidder, K. Ecology and life history of *Nereocystis luetkeana* in the South Slough Estuary. University of Oregon Department of Biology (2006)
[32] Springer, Y., et al., Toward ecosystem-based management of marine macroalgae - the bull kelp Nereocystis luekeana, 48 Oceanography and Marine Biology An Annual Review 1 (2010)
[33] Sanctuary Integrated Monitoring Network. Bull Kelp. Accessed August 17, 2022: https://sanctuarysimon.org/dbtools/species-database/id/75/nereocystis/luetkeana/bull-kelp/
[34] Kidder et al. 2006 citing Amsler, C. D., The behavior, physiology, and release of kelp spores. Santa Barbara, University of California., Ph.D.: 254 (1989) and Kemp, L. & Cole, K., Chromosomal alternation of generations in Nereocystis luetkeana (Mertens) Postels and Ruprecht, 39 Canadian Journal of Botany 1711 (1961); Sanctuary Integrated Monitoring Network. Bull Kelp. Accessed August 17, 2022: https://sanctuarysimon.org/dbtools/species-database/id/75/nereocystis/luetkeana/bull-kelp/
[35] Sanctuary Integrated Monitoring Network. Bull Kelp. Accessed August 17, 2022: https://sanctuarysimon.org/dbtools/species-database/id/75/nereocystis/luetkeana/bull-kelp/
[36] Kidder et al. 2006 citing Amsler, C. D., The behavior, physiology, and release of kelp spores. Santa Barbara, University of California., Ph.D.: 254 (1989)
[37] Kidder et al. 2006 citing Vadas, R. Ecological implications of culture studies on Nereocystis leutkeana, 8 Journal of Phycology 196 (1972); Sanctuary Integrated Monitoring Network. Bull Kelp. Accessed August 17, 2022: https://sanctuarysimon.org/dbtools/species-database/id/75/nereocystis/luetkeana/bull-kelp/
[38] Sanctuary Integrated Monitoring Network. Bull Kelp. Accessed August 17, 2022: https://sanctuarysimon.org/dbtools/species-database/id/75/nereocystis/luetkeana/bull-kelp/
[39] Kidder et al. 2006 citing Vadas, R. Ecological implications of culture studies on Nereocystis leutkeana, 8 Journal of Phycology 196 (1972)
[40] Kidder et al. 2006 citing Vadas, R. Ecological implications of culture studies on Nereocystis leutkeana, 8 Journal of Phycology 196 (1972)
[41] Sanctuary Integrated Monitoring Network. Bull Kelp. Accessed August 17, 2022: https://sanctuarysimon.org/dbtools/species-database/id/75/nereocystis/luetkeana/bull-kelp/
[42] *Id.*

Once the female gamete (egg) is fertilized by the male gamete (sperm), the algae develops into a sporophyte.[43] Juvenile bull kelp have high mortality rates,[44] but they grow into adults quickly.[45] During the summer, bull kelp can grow up to 25 cm per day.[46] When the bull kelp grows long enough to reach the surface of the water, the rate of growth slows, and the algae dedicates more energy to producing spores.[47]

CAUSES OF MORTALITY

The bull kelp faces several causes of mortality, many of which are exacerbated by human activity. Many of the bull kelps' natural sources of mortality are worsened especially by climate change. Bull kelp have often been detached from their substrate by winter storms,[48] and with climate change, winter storms are becoming more frequent and more extreme.[49] Bull kelp also face predation from sea urchins,[50] and since sea stars and southern sea otters – natural predators of sea urchins – have experienced mass die-offs, bull kelp face higher levels of predation from sea urchins.[51] As climate change continues to worsen, these other threats grow increasingly concerning.

Bull kelp requires high nutrient availability, cool water temperatures, and high light availability to thrive and to effectively reproduce. Due to coastal development and climate change, all are under threat. Bull kelp can also be harmed by chemical pollution, like heavy metals and petroleum, both of which increase with coastal industry.

All these effects are discussed in more detail in Part II of this listing petition.

ABUNDANCE AND POPULATION TRENDS

The first record of bull kelp populations was made in the early 1900s[52], and more regular habitat scale tracking is available starting in the mid-1980s.[53] As an annual species, bull kelp experiences regular

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[43] Kidder et al. 2006 citing Foreman, R. E., Studies on Nereocystis growth in British Columbia. 116 Hydrobiologia 325 (1984)

[44] *Id.*

[45] Kidder et al. 2006 citing Denny, M. & Cowen, B., Flow and flexibility. II. The roles of size and shape in determining wave forces on the bull kelp Nerocystis luetkeana, 200 Journal of Experimental Biology 3165 (1997)

[46] Sanctuary Integrated Monitoring Network. Bull Kelp. Accessed August 17, 2022: https://sanctuarysimon.org/dbtools/species-database/id/75/nereocystis/luetkeana/bull-kelp/

[47] *Id.*

[48] Springer, Y., et al., Toward ecosystem-based management of marine macroalgae - the bull kelp Nereocystis luekeana, 48 Oceanography and Marine Biology An Annual Review 1 (2010)

[49] Intergovernmental Panel on Climate Change, Climate Change 2021: They Physical Science Basis Summary for Policymakers, (2021) https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

[50] Rogers-Bennet & Catton, Marine heat wave and multiple stressors tip bull kelp forest to sea urchin barrens, 9 Nature Scientific Reports 15050 (2019)

[51] *Id.*; Davis, R. W., et al., Future Directions in Sea Otter Research and Management, 5 Fronteirs in Marine Science 510 (2019); U.S. Fish and Wildlife Service, Southern Sea Otter (*Enhydra lutris nereis*) Stock Assessment Report (2021) Accessed: https://www.fws.gov/species/southern-sea-otter-enhydra-lutris-nereis

[52] Frye, T. C. Nereocystis luetkeana. 42 *Botanical Gazette* 143 (1906)

[53] Finger, D., et al., Mapping bull kelp canopy in northern California using Landsat to enable long-term monitoring, 254 Remote Sensing of Environment 112243 (2021); Bell, T., Kelpwatch: A new visualization and analysis tool to explore kelp canopy dynamics reveals variable resistance and resilience to marine heat waves. bioRxiv (2022)

boom and bust cycles and until recently has always recovered to standard population densities.[54] However, there have been alarmingly severe bull kelp population declines since 2014, and kelp have not recovered as they should.[55] Some environmental phenomena that can affect bull kelp populations include heat and turbidity, both of which can cause declines in local bull kelp populations.[56]

Globally, kelp populations have declined slightly, but there is a high degree of local variation within those trends.[57] Overall populations trends were negative in Northern and Central California from 1983 to 2012, where bull kelp are one of two primary kelp species.[58] Populations trends were also negative in the Aleutian Islands, where bull kelp is the primary kelp species.[59] Remote sensing using satellites is a useful method to study habitat range and density over time. A study using images from Landsat, a satellite system by USGS that has photographed the entire world every sixteen days since 1972, found that canopy cover of bull kelp in Northern California decreased noticeably from 2014 to 2016.[60]

Kelp population trends off the coast of Western North America (where bull kelp are one of two dominant kelp species) have been concerningly in decline.[61] During the year 2014, bull kelp canopy decreased by over 90% along the California coast in Sonoma and Mendocino counties, where bull kelp have historically thrived.[62] Though it is normal for bull kelp to experience some variability in population size from year to year, 2014 to 2021 was the longest period bull kelp has gone without recovering in the last 38 years.[63] Bull kelp declines are likely due to the marine heat wave called "The Blob," as well as the 2015/2016 ENSO event.[64]

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[54] Bell, T., Kelpwatch: A new visualization and analysis tool to explore kelp canopy dynamics reveals variable resistance and resilience to marine heat waves. bioRxiv (2022); Krumhansl, K., et al. Global patterns of kelp forest change over the past half-century. 113 Proceedings in National Academy of Sciences 48 (2016)

[55] Rogers-Bennet & Catton, Marine heat wave and multiple stressors tip bull kelp forest to sea urchin barrens, 9 Nature Scientific Reports 15050 (2019); Bell, T., Kelpwatch: A new visualization and analysis tool to explore kelp canopy dynamics reveals variable resistance and resilience to marine heat waves. bioRxiv (2022)

[56] Blain, C., et al., Coastal darkening substantially limits the contribution of kelp to coastal carbon cycles, 27 Global Change Biology 5547 (2021); Rogers-Bennett, L & Catton, C. A., Marine heat wave and multiple stressors tip bull kelp forest to sea urchin barrens, 9 Scientific reports 1 (2019)

[57] Krumhansl, K., et al. Global patterns of kelp forest change over the past half-century. 113 Proceedings in National Academy of Sciences 48 (2016)

[58] *Id.*

[59] *Id.*

[60] Finger, D., et al., Mapping bull kelp canopy in northern California using Landsat to enable long-term monitoring, 254 Remote Sensing the Environment 112243 (2021)

[61] Bell, T., Kelpwatch: A new visualization and analysis tool to explore kelp canopy dynamics reveals variable resistance and resilience to marine heat waves. bioRxiv (2022); Rogers-Bennet & Catton, Marine heat wave and multiple stressors tip bull kelp forest to sea urchin barrens, 9 Nature Scientific Reports 15050 (2019); Pfister, C. A., The dynamics of kelp forests in the northeast pacific ocean and the relationship with environmental drivers, 106 Journal of Ecology 1520 (2017)

[62] Rogers-Bennet & Catton, Marine heat wave and multiple stressors tip bull kelp forest to sea urchin barrens, 9 Nature Scientific Reports 15050 (2019)

[63] Bell, T., Kelpwatch: A new visualization and analysis tool to explore kelp canopy dynamics reveals variable resistance and resilience to marine heat waves. bioRxiv (2022)

[64] Tseng, Y., et al. The warm Blob in the northeast Pacific—the bridge leading to the 2015/16 El Niño, 12 Environmental Research Letters 054019 (2017); Rogers-Bennet & Catton, Marine heat wave and multiple stressors tip bull kelp forest to sea urchin barrens, 9 Nature Scientific Reports 15050 (2019)

Local human influences also play a role in bull kelp population decline; a 2017 paper studying kelp off the coast of Washington found that areas of kelp population decline are closer to human populations.[65] The authors stressed that there is substantial evidence that kelp population declines are associated with warmer temperatures, indicating that future climate change is a concerning threat to kelp populations.[66]

CONSERVATION STATUS

Bull kelp does not currently hold protected status under any environmental law. The National Marine Sanctuaries overlap with some bull kelp habitat, but they do not extend throughout the bull kelp's habitat range and therefore do not provide adequate protection to the species. Furthermore, some of the recent mass die-offs of kelp occurred in the National Marine Sanctuaries, highlighting that the protections they provide are insufficient to protect bull kelp from extinction threats.

PART II: BULL KELP QUALIFIES AS THREATENED OR ENDANGERED UNDER THE ESA

THE PRESENT OR THREATENED DESTRUCTION, MODIFICATION, OR CURTAILMENT OF THE BULL KELP HABITAT OR RANGE

Climate change is a present and ongoing threat to bull kelp in the Northeastern Pacific. Bull kelp thrive in cold, nutrient rich water which is facilitated by coastal upwelling along the coast of western North America.[67] Climate change is and will continue to cause an increase in the average temperature of the water and exacerbate irregular temperature extremes.[68] Over the past decade, the bull kelp's habitat experienced one of the most extreme El Niño events in recorded history as well as an abnormal marine heat wave colloquially coined "The Blob."[69]

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[65] Pfister, C., et al., The dynamics of Kelp Forests in the Northeast Pacific Ocean and the relationship with environmental drivers, 106 Journal of Ecology 1520 (2018)

[66] *Id.*

[67] Springer, Y., et al., Toward Ecosystem-Based Management of Marine Macroalgae – The Bull Kelp, *Nereocystis luetkeana*, 48 Oceanography and marine biology 1 (2010)

[68] Intergovernmental Panel on Climate Change, Climate Change 2021: They Physical Science Basis Summary for Policymakers, (2021) https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf; Intergovernmental Panel on Climate Change, Special Report on the Ocean and Cryosphere in a Changing Climate, Chapter 5: Changing Ocean, Marine Ecosystems, and Dependent Communities (2019) https://www.ipcc.ch/site/assets/uploads/sites/3/2022/03/07_SROCC_Ch05_FINAL.pdf ; Hayhoe, K. J., et al., Climate models, scenarios, and projections. In: *Climate Science Special Report: Fourth National Climate Assessment, Volume I* [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)] U.S. Global Change Research Program 133 (2017); Doney, S. C., et al., Climate Change Impacts on Marine Ecosystems, 4 Annual Reviews in Marine Science 11 (2012); Barth, J. A., et al., Delayed upwelling alters nearshore coastal ocean ecosystems in the northern California current, 104 PNAS 3719 (2007); Herring, S. C., et al., Eds., Explaining Extreme Events of 2016 from a Climate Perspective, 99 Bulletin of the American Meteorological Society S1 (2018)

[69] Tseng, Y., et al. The warm Blob in the northeast Pacific—the bridge leading to the 2015/16 El Niño, 12 Environmental Research Letters 054019 (2017); Rogers-Bennet & Catton, Marine heat wave and multiple stressors tip bull kelp forest to sea urchin barrens, 9 Nature Scientific Reports 15050 (2019); McPhadden, M., et al., El Niño Southern Oscillation in a Changing Climate, American Geophysical Union (2020)

El Niño, the warm phase of the El Niño Southern Oscillation (ENSO), is an atmospheric and oceanic phenomenon in the Pacific Ocean that occurs every 2-7 years.[70] During an El Niño event, easterly trade winds weaken, which then slows the current that usually moves surface water away from the Western American coast.[71] Under normal conditions, when the current moves surface water away from the coast, cold, nutrient rich water from the deep-sea flows up to the surface, fueling a thriving and biodiverse ecosystem.[72] When that current weakens, warm, nutrient poor surface water stays in place,[73] which can be harmful to some species that live along the coast including bull kelp.

The Blob was a marine heat wave in the Northern Pacific Ocean that started in 2013 and continued through 2015.[74] During The Blob, sea surface water reached temperatures over 2.5°C higher than the mean in some regions, including the Gulf of Alaska.[75] It was followed by the 2015/2016 El Niño event, which is one of the strongest El Nino events on record, resulting in temperature anomalies over 3°C above the mean.[76]

The Blob and El Niño are useful natural experiments to study what the effects of increasing climate change will be on species in the Northeastern Pacific. The effects of these natural phenomena – especially increased mean sea surface temperature – can be used to realistically infer what will occur as climate change worsens. These events caused unprecedented warming along the coast of Western North America, and in that time bull kelp populations crashed. Bull kelp populations did not recover for approximately eight years, and it is still to be seen if they will. Though bull kelp populations do experience some regular boom and bust cycles as an annual algae species, this is the longest amount of time bull kelp populations have gone without recovery for 38 years.[77] This warm period has shown that bull kelp struggle to recover from extended warm periods, and provides a window into the danger that future climate warming poses to the species.[78] Not only does bull kelp struggle to recover after warming events, it has also become less resilient and less resistant to heat waves.[79] One study looking at a different kelp species in Australia found that warmer water prevented kelp recovery because it decreased recruitment and recruit survival.[80] Furthermore, all reliable climate projects predict that not

[70] NOAA, El Niño/Southern Oscillation (ENSO), NOAA National Centers for Environmental Information (2022). https://www.ncei.noaa.gov/access/monitoring/enso/ Accessed: August 19, 2022
[71] *Id.*
[72] *Id.*
[73] *Id.*
[74] Tseng, Y., et al. The warm Blob in the northeast Pacific—the bridge leading to the 2015/16 El Niño, 12 Environmental Research Letters 054019 (2017)
[75] *Id.* citing Bond, N.A., et al., Recent shifts in the state of the North Pacific, 30 Geophysical Research Letters 1 (2003)
[76] Tseng, Y., et al. The warm Blob in the northeast Pacific—the bridge leading to the 2015/16 El Niño, 12 Environmental Research Letters 054019 (2017)
[77] Bell, T., Kelpwatch: A new visualization and analysis tool to explore kelp canopy dynamics reveals variable resistance and resilience to marine heat waves. bioRxiv (2022)
[78] *Id.*
[79] *Id.*
[80] Wernberg, T., et al., Decreasing resilience of kelp beds along a latitudinal temperature gradient: potential implications for a warmer future. 13 Ecology Letters 685 (2010)

only will the mean temperature continue to increase, extreme climate events like storms — which have been shown to uproot bull kelp from their substrate — will occur more frequently in the future.[81]

As a result, climate change threatens to destroy, modify, and curtail bull kelp habitat both presently and in the future.

OVERUTILIZATION FOR COMMERCIAL, RECREATIONAL, SCIENTIFIC, OR EDUCATIONAL PURPOSES

Commercial bull kelp harvesting threatens the continued survival of bull kelp. Commercial bull kelp harvesting started in the 1980s.[82] While the quantity of harvest *per se* is not a threat, the method of harvest is problematic.[83] Bull kelp are usually harvested by boat, and only the top 2 meters are harvested.[84] However, that removes the part of the kelp that keeps it buoyant and reproduces, which can then prevent future reproduction.[85] Commercial harvest thus may pose an overutilization threat to bull kelp if the harvest method prevents the persistence of bull kelp forests.[86]

In response to devastating declines of bull kelp along the northern California coast, in 2021 the California Department of Fish and Wildlife has suggested temporary closures of kelp harvest.[87] A three-year temporary closure was approved in February 2022, halting all harvest off Sonoma and Mendocino counties; limiting harvest off Humboldt and Del Norte counties; and closing three lease-only kelp beds in Mendocino, Humboldt, and Del Norte counties.[88] These time-limited harvest limits are indicative that bull kelp is endangered, but are inadequate to address the scope of the threats to the species.

DISEASE OR PREDATION

Predation by sea urchins poses a threat to bull kelp forests. The kelp, sea otter, and sea urchin trophic cascade is well-established in scientific literature and is also commonly taught as a prime example of how an imbalance in trophic interactions can devastate an ecosystem. It was first studied experimentally

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[81] Intergovernmental Panel on Climate Change, Climate Change 2021: They Physical Science Basis Summary for Policymakers, (2021) https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf; Tohver, I. M., et al., Impacts of 21st-Century Climate Change on Hydrologic Extremes in the Pacific Northwest Region of North America, 50 Journal of the American Water Resources Association 1461 (2014); Springer, Y., et al., Toward ecosystem-based management of marine macroalgae - the bull kelp Nereocystis luekeana, 48 Oceanography and Marine Biology An Annual Review 1 (2010); McPhadden, M., et al., El Niño Southern Oscillation in a Changing Climate, American Geophysical Union (2020); NOAA Research News, How will climate change change El Niño and La Niña? Accessed August 18, 2022: https://research.noaa.gov/article/ArtMID/587/ArticleID/2685/New-research-volume-explores-future-of-ENSO-under-influence-of-climate-change

[82] Springer, Y., et al., Toward ecosystem-based management of marine macroalgae - the bull kelp Nereocystis luekeana, 48 Oceanography and Marine Biology An Annual Review 1 (2010)

[83] *Id.*

[84] *Id.*

[85] *Id.*

[86] *Id.*

[87] Hill & Lyons, Proposed Bull Kelp Harvest Limits Could Help Address Climate-Driven Collapse of Vital Marine Algae, The PEW Charitable Trusts (2021)

[88] California Fish and Game Commission, Item 8 – Commercial Kelp and Other Aquatic Plants

by David Duggins in 1980.[89] When sea otters are removed, urchin populations explode and decimate kelp populations.[90] Once rich and diverse kelp forests are reduced to "urchin barrens."[91] The loss of other urchin predators can have similar effects.[92]

Purple sea urchin barrens have occurred all along the North American west coast, from north of San Francisco to the Oregon border, and even off the coast of British Columbia.[93] While that region has historically hosted a thriving bull kelp population, the 2014 marine heatwave - often called "The Blob" - caused sea star wasting disease, which lead to a mass mortality event of sunflower sea stars. Sunflower sea stars are a purple sea urchin predator, and when the sea stars died off *en masse*, sea urchins thrived. Since sea urchins prey on kelp, an increasing urchin population coupled with kelp die-offs due to the heat wave caused areas of the coast to shift from being kelp forests to urchin barrens.[94] Furthermore, sunflower sea stars have not recovered from the marine heatwave and are classified as critically endangered by the IUCN,[95] indicating that the threat of urchin barrens will persist for the foreseeable future.

Purple sea urchins become more aggressive in urchin barrens, and will eat subcanopy kelp, fleshy algae, and calcified crustose coralline algae.[96] Sea urchin barrens may be alternate stable-states of kelp ecosystems, meaning that once an ecosystem goes to being an urchin barren, it will be difficult for it to return to a kelp forest state.[97] Sea urchin barrens are highly resilient,[98] and since kelp resiliency is decreasing due to human impacts like climate change,[99] barrens will continue to pose an increasing threat to kelp. Sea urchin predation is worsened by climate change. Climate change is associated with

[89] Duggins, D., Kelp beds and sea otters: An experimental approach, 61 Ecological Society of America 447 (1980)
[90] Davis, R. W., et al., Future Directions in Sea Otter Research and Management, 5 Fronteirs in Marine Science 510 (2019); Duggins, D., Kelp beds and sea otters: An experimental approach, 61 Ecological Society of America 447 (1980)
[91] *Id.*
[92] Duggins, D., Kelp beds and sea otters: An experimental approach, 61 Ecological Society of America 447 (1980); Rogers-Bennet & Catton, Marine heat wave and multiple stressors tip bull kelp forest to sea urchin barrens, 9 Nature Scientific Reports 15050 (2019)
[93] Rogers-Bennet & Catton, Marine heat wave and multiple stressors tip bull kelp forest to sea urchin barrens, 9 Nature Scientific Reports 15050 (2019); Starko, S., et al., Microclimate predicts kelp forest extinction in the face of direct and indirect marine heatwave effects, *Ecological Applications* e2673 (2022)
[94] *Id.*
[95] CA Department of Fish and Wildlife, Bull Kelp Working Group December 2020 Meeting Notes, (2020); IUCN Red List of Threatened Species, Amazing Species: Sunflower Sea Star, (2021); Gravem, S. A., et al., Pycnopodia helianthoides (amended version of 2020 assessment), The IUCN Red List of Threatened Species e.T178290276A197818455 (2021)
[96] Starko, S., et al., Microclimate predicts kelp forest extinction in the face of direct and indirect marine heatwave effects, *Ecological Applications* e2673 (2022)
[97] Filbee-Dexter & Scheibling, Sea urchin barrens as alternative stable states of collapsed kelp ecosystems, 495 Marine Ecology Progress Series 1 (2014); Ling, S. D., et al., Global regime shift dynamics of catastrophic sea urchin overgrazing, 370 Philosophical Transactions of the Royal Society B: Biological Sciences 20130269 (2015)
[98] Ling, S. D., et al., Global regime shift dynamics of catastrophic sea urchin overgrazing, 370 Philosophical Transactions of the Royal Society B: Biological Sciences 20130269 (2015)
[99] Ling, S. D., et al., Global regime shift dynamics of catastrophic sea urchin overgrazing, 370 Philosophical Transactions of the Royal Society B: Biological Sciences 20130269 (2015);

increased and stronger storm events, which can dislodge kelp from kelp forests.[100] This can decrease kelp density, which can in turn increase predation from sea urchins.[101] In sum, urchin predation poses a significant threat to bull kelp and increases the species' risk of extinction.

INADEQUACY OF EXISTING REGULATORY MECHANISMS

There are no existing regulatory mechanisms that are sufficient to protect this algae from extinction. Although some bull kelp habitat is protected by National Marine Sanctuaries, these sanctuaries have so far failed to prevent population declines. Furthermore, the National Marine Sanctuaries only protect the southernmost part of the bull kelp habitat range. There are no National Marine Sanctuaries in Washington or Alaska, where bull kelp are the dominant canopy-building kelp species. Listing of the bull kelp as a threatened or endangered species and designating critical habitat under the ESA is necessary to provide critical legal protections to ensure the survival of this highly imperiled algae species.

OTHER NATURAL OR MANMADE FACTORS AFFECTING THE BULL KELP'S CONTINUED EXISTENCE

Chemical and thermal pollution, coastal darkening, and oil spills all pose risks to bull kelp and place the species at risk of extinction.

A. Chemical Pollution

Chemical pollutants impact bull kelp health and reproduction. As a coastal species, bull kelp are exposed to chemical pollution from anthropogenic sources along the coast. Bull kelp is especially sensitive to the chemical hydrazine.[102] Hydrazine is used to decrease corrosion in high-pressure boilers,[103] in pesticides,[104] and in military and aviation industries.[105] When exposed to hydrazine, bull kelp gametophytes and sporophytes didn't develop, threatening kelp's ability to reproduce.[106] As a result, pollution and runoff from coastal airports, military bases, and factories endanger bull kelp's ability to reproduce and survive.

In a study on another kelp species in the same order, researchers found that populations that were chronically exposed to heavy metal pollution had small adult sizes, small holdfast areas, lower spore release, lower spore settlement, a higher percentage of undifferentiated gametophytes, and decreased

[100] Springer, Y., et al., Toward ecosystem-based management of marine macroalgae - the bull kelp Nereocystis luekeana, 48 Oceanography and Marine Biology An Annual Review 1 (2010)
[101] Springer et al. 2010, citing Dayton, P., et al., Spatial and temporal patterns of disturbance and recovery in a kelp forest community, 62 Ecological Monographs 421 (1992)
[102] Springer, Y., et al., Toward ecosystem-based management of marine macroalgae - the bull kelp Nereocystis luekeana, 48 Oceanography and Marine Biology An Annual Review 1 (2010)
[103] *Id.*
[104] National Institute for Occupational Safety and Health, Hydrazine, Center for Disease Control and Prevention, Accessed August 24, 2022: https://www.cdc.gov/niosh/topics/hydrazine/default.html
[105] Nguyen, H. N., et al., The Toxicity, Pathophysiology, and Treatment of Acute Hydrazine Propellant Exposure: A Systematic Review, 186 Military Medicine e319 (2021)
[106] *Id.*

fertility.[107] Heavy metals can be found in stormwater runoff along the western United States in bull kelp habitat range, and therefore a threat to bull kelp survival.[108]

Chemical pollution from coastal factories, military bases, and airports pose a significant threat to bull kelp health, reproductive capacity, and survival.

B. Thermal Pollution

Thermal pollution is also a concern for coastal species like the bull kelp. Bull kelp can reproduce when water temperatures are between 3 and 15 degrees C.[109] In a 1987 report, Pacific Gas & Electric found that bull kelp populations declined in the area where there was warm water discharge from the Diablo Canyon Power Plant.[110] Not only do coastal industries pose a chemical threat to bull kelp, they also pose a thermal one.

C. Coastal Darkening

Not only does pollution from coastal runoff have negative chemical effects on kelp, it also has negative physical effects. A recently discovered phenomenon called coastal darkening describes when pollutants from coastal runoff physically block the sun and decrease photosynthesis.[111] A study on the spiny kelp *Ecklonia radiata* in New Zealand found that a 63% reduction in light due to pollution caused a 95% decrease in kelp productivity.[112] *Nereocystis* is similarly sensitive to turbidity.[113] Light availability is one of the most important environmental factors for bull kelp growth and sexual maturation.[114] Light permeation in California coastal waters can be reduced by several human activities, including particulate runoff from land, sediment suspension as a result of dredging, or storm surge.[115] Storm surge is expected to get worse as climate change continues to worsen.[116] In one example in the winter of 1968-69, there was a storm that caused heavy rains, which in turn caused increased runoff. Both phenomena combined increased turbidity in the water, and afterwards no bull kelp sporophytes were seen in the area for five months. When the kelp finally did return, it was a quarter the size as it was the year

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[107] Oyarzo-Miranda, C., et al., Coastal pollution from the industrial park Quintero bay of central Chile: Effects on abundance, morphology, and development of the kelp Lessonia spicata (Phaeophyceae), 15 PLOS ONE e0240581 (2020)

[108] Lau, S-L., et al., Characteristics of Highway Stormwater Runoff in Los Angeles: Metals and Polycyclic Aromatic Hydrocarbons, 81 Water Environment Research 308 (2009); California Department of Transportation, Storm Water Monitoring & Data Management Discharge Characterization Study Report, 2003; McIntyre, J. K., et al., Interspecies variation in the susceptibility of adult Pacific salmon to toxic urban stormwater runoff, 238 Environmental Pollution 196 (2018)

[109] Springer et al. 2010 citing Vadas, R. Ecological implications of culture studies on Nereocystis leutkeana, 8 Journal of Phycology 196 (1972)

[110] Springer, Y., et al., Toward ecosystem-based management of marine macroalgae - the bull kelp Nereocystis luekeana, 48 Oceanography and Marine Biology An Annual Review 1 (2010)

[111] Blain, C., et al., Coastal darkening substantially limits the contribution of kelp to coastal carbon cycles, 27 Global Change Biology 5547 (2021)

[112] *Id.*

[113] Springer, Y., et al., Toward ecosystem-based management of marine macroalgae - the bull kelp Nereocystis luekeana, 48 Oceanography and Marine Biology An Annual Review 1 (2010)

[114] *Id.*

[115] *Id.*

[116] Intergovernmental Panel on Climate Change, Climate Change 2021: They Physical Science Basis Summary for Policymakers, (2021) https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

before.[117] There is also evidence that bull kelp recruitment is limited by light availability,[118] indicating that coastal darkening may limit bull kelp's ability to reproduce. Coastal darkening thus poses a threat to bull kelp, increasing the species' risk of extinction.

D. Oil Spills

Oil spills are another form of pollution that threatens bull kelp. Oil spills expose bull kelp to petroleum products. In coastal oil spills, oil can be temporarily trapped in kelp beds, exposing the kelp to oil for a long period of time.[119] In a 1995 experiment, bull kelp was exposed to different petroleum products for 4-24 hours and then monitored for 7 days.[120] The researchers found that petroleum exposure caused a defined bleached line through any tissue that came in direct contact with petroleum. It also caused color loss that increased with duration of exposure and tissue necrosis. Petroleum also damaged the part of the kelp where the stipe and bulb connect, which is where the kelp grows from. When bull kelp was exposed to unweathered diesel, photosynthesis in blade stopped completely and photosynthesis in the stipe decreased by about 75%. When exposed to both weathered and unweathered diesel and intermediate fuel oil (IFO), the ratio of net photosynthetic rate (NP) to respiration (R) was low, which indicates that the kelp is using more oxygen than it's producing. In a healthy kelp, NP:R should equal 1.[121]

Oil is an imminent threat to bull kelp, especially within its Californian and Alaskan habitats. In California, there have been two infamously large oil spills in bull kelp habitat – the 1969 Santa Barbara oil spill and the 2015 Refugio State Beach oil spill.[122] In Alaska, the recent Inflation Reduction Act mandates the sale of oil and gas leases in Cook Inlet. Inflation Reduction Act, H. R. 5376, 117th Cong. (2nd Sess. 2022). and there are already 17 oil and gas platforms in the inlet.[123] The existing infrastructure is old and corroded and is likely to leak.[124] Cook Inlet overlaps with bull kelp habitat, and a large spill in Cook Inlet could be devastating to the local bull kelp population.[125]

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[117] Springer, Y., et al., Toward ecosystem-based management of marine macroalgae - the bull kelp Nereocystis luekeana, 48 Oceanography and Marine Biology An Annual Review 1 (2010)
[118] Springer et al. 2010 citing Vadas, R. Ecological implications of culture studies on Nereocystis leutkeana, 8 Journal of Phycology 196 (1972)
[119] Foster, M., et al., The Santa Barbara Oil Spill Part 1: Initial Quantities and Distribution of Pollutant Crude Oil, 2 Environmental Pollution 97 (1971)
[120] Antrium, L. D., et al., Effects of petroleum products on bull kelp (*Nereocystis leutkeana*), 122 Marine Biology 23 (1995)
[121] Antrium, L. D., et al., Effects of petroleum products on bull kelp (*Nereocystis leutkeana*), 122 Marine Biology 23 (1995)
[122] Clarke & Hemphill, The Santa Barbara Oil Spill: A Retrospective, 64 Yearbook of the Association of Pacific Coast Geographers 157 (2002); NOAA Damage Assessment, Remediation, and Restoration Program, Refugio Beach Oil Spill, Accessed July 27, 2022: https://darrp.noaa.gov/oil-spills/refugio-beach-oil-spill
[123] DeMarben, Alex, Alaska's antiquated Cook Inlet pipelines causing alarm after leaks, Alaska Dispatch News (2017) Accessed August 25, 2022: https://www.rcinet.ca/eye-on-the-arctic/2017/04/11/antiquated-cook-inlet-pipelines-targeted-amid-busy-season-for-oil-and-gas-leaks/
[124] *Id.*
[125] *Id.*

Polycyclic aromatic hydrocarbons (PAHs), a highly toxic chemical byproduct of fossil fuels, also threaten bull kelp.[126] PAHs can get into the marine ecosystem through both oil spills and stormwater runoff.[127] PAHs can act as a solvent for chlorophyll, leading to bleaching of bull kelp and decrease in photosynthesis.[128] When combined with heavy metals, PAHs are especially toxic to early life stages of kelp.[129] Metals and PAHs are commonly found together in stormwater.[130] Not only does offshore oil drilling further endanger bull kelp's ability to survive and persist, stormwater runoff exacerbates the threat.

PART III. CRITICAL HABITAT DESIGNATION

The ESA mandates that, when NMFS lists a species as endangered or threatened, the agency must also concurrently designate critical habitat for that species. 16 U.S.C. § 1533(a)(3)(A)(i); see also id. at § 1533(b)(6)(C); see also *Weyerhaeuser Co. v. United States Fish & Wildlife Serv.*, 139 S. Ct. 361 (2018) (stating that the ESA "directs the Secretary of the Interior, upon listing a species as endangered, to also designate the 'critical habitat' of the species.).

The ESA defines "critical habitat" as:

a. [T]he specific areas within the geographical area occupied by the species . . . on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and
b. [S]pecific areas outside the geographical area occupied by the species . . . upon a determination by the Secretary that such areas are essential for the conservation of the species." *Id.* at § 1532(5)(A).

Congress recognized that the protection of habitat is essential to the recovery and/or survival of listed species, stating that, "classifying a species as endangered or threatened is only the first step in insuring its survival. Of equal or more importance is the determination of the habitat necessary for that species' continued existence. If the protection of endangered and threatened species depends in large measure on the preservation of the species' habitat, then the ultimate effectiveness of the Endangered Species Act will depend on the designation of critical habitat." H. Rep. No. 94-887 at 3 (1976).

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Critical habitat is an effective and important component of the ESA, without which bull kelp has a minimal long-term chance for survival. Petitioners thus request that the FWS propose critical habitat for all currently occupied bull kelp habitat concurrently with its proposed listing.

PART IV. CONCLUSION

The bull kelp is a critically important species of algae that is highly sensitive to physical changes in its marine environment. Bull kelp requires cool temperatures, plenty of light and nutrients, and high population density to survive and to successfully reproduce. Unfortunately, bull kelp are at risk from increasing temperatures, increased extreme heat events, and increased storm surges due to climate change; thermal pollution, heavy metal pollution, coastal darkening, predation from sea urchins that is exacerbated by climate change, and oil spills from offshore drilling. These threats are likely to result in the destruction of kelp populations and the prevention of kelp reproduction. Existing regulatory mechanisms are inadequate to protect this species from extinction. Bull kelp needs ESA protection, including critical habitat designation, to ensure its continued existence in the face of ongoing threats.

Petitioners request the bull kelp be listed as endangered under the ESA and request that NMFS designate critical habitat for the species within U.S. waters. Listing will significantly improve the species' conservation prospects by reducing key threats and by increasing global awareness, catalyzing additional research, and forging national and international conservation partnerships. Petitioners urge NMFS to grant the actions requested herein without delay.

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