

# Compatibility Determination

## Title

Compatibility Determination for Photography, Mariana Arc of Fire National Wildlife Refuge within the Mariana Trench Marine National Monument.

## Refuge Use Category

Wildlife Observation and Photography

## Refuge Use Type(s)

*Photography.* Refuge visitation for the purpose of photographing refuge natural or cultural resources (including fish, wildlife, plants, and their habitats) or public uses of those resources. Includes still photography, photography, videography, filming, or other recording of sight or sound.

## Refuge

Mariana Arc of Fire National Wildlife Refuge

## Refuge Purpose(s) and Establishing and Acquisition Authority(ies)

*Mariana Arc of Fire NWR:*

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ... 16 U.S.C. § 742f(a)(4) "... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956).

"... conservation, management, and ... restoration of the fish, wildlife, and plant resources and their habitats ... for the benefit of present and future generations of Americans..." 16 U.S.C. § 668dd(a)(2) (National Wildlife Refuge System Administration Act).

"... suitable for— (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. § 460k-1 "... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ..." 16 U.S.C. § 460k-2 (Refuge Recreation Act (16 U.S.C. § 460k-460k-4), as amended).

*Mariana Trench Marine National Monument:*

"...for the purpose of protecting the objects identified above..." "... [Interior

Secretary] shall not allow or permit any appropriation, injury, destruction, or removal of any feature of this monument except as provided for by this proclamation or as otherwise provided for by law”. (Presidential Proclamation 8335)

“...Regulation of Scientific Exploration and Research...Subject to such terms and conditions as the Secretary deems necessary for the care and management of the objects of this monument, the Secretary of the Interior may permit scientific exploration and research within the monument, including incidental appropriation, injury, destruction, or removal of features of this monument for scientific study...” (Presidential Proclamation 8335)

“...For each of the areas subject to this delegation, the Director of the [USFWS] shall provide for the proper care and management of the monument, including all objects of scientific and historic interest therein; the conservation of fish and wildlife; and the development of programs to assess and promote national and international monument-related scientific exploration and research.” (Section 4.a.(2) . . . subject to the provisions of the proclamation [8335] establishing this Monument. . .).” (Secretarial Order 3284).

## **National Wildlife Refuge System Mission**

The mission of the National Wildlife Refuge System, otherwise known as Refuge System, is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans (Pub. L. 105-57; 111 Stat. 1252).

## **Description of Use**

Is this an existing use?

Yes.

This use was reevaluated concurrently with the preparation of the Draft Mariana Trench Marine National Monument Management Plan and Environmental Assessment (USFWS 2020).

What is the use?

We propose to allow Refuge visitation for the purpose of photographing refuge natural or cultural resources (including fish, wildlife, plants, and their habitats) or public uses of those resources. “Photography” includes still photography, videography, filming, or other recording of sight or sound to be made within the Refuge. The Service and the Department of the Interior do not distinguish between different types of filming activity (e.g. filming for personal, commercial, news, or educational purposes).

Any photography or other recording activities conducted in the extreme environment of the Mariana Arc of Fire NWR are 1) functionally the same; and 2) limited to a few individuals and institutions that have the fiscal and technical capability to access deep-sea areas. For example, the permittee may film the ocean floor, record the sounds of venting from white smokers, and video explorers and scientists in their work.

It is likely that such photographs, video, or audio recordings would have commercial value and there would be intentions of some commercial use. However, the Service and the Department of the Interior do not distinguish between different types of filming activity and do not regulate commercial filming or videography specifically. Commercial still photography and audio recordings may be regulated, however we expect that the primary activity being permitted would be video recording.

Because recordings of extreme deep-sea environments are novel and exceptional throughout the world, they would be of immense interest to schools and educational institutions, news media, and both commercial and public broadcasting organizations. Recordings may be included in a live “virtual classroom” event, be broadcast through news media, and be the subject of a documentary. Recordings of deep-sea environments are appealing to the general public because they expose an exceptional environment, representing some of the last frontiers of discovery on Earth. They are also captivating because deep-sea environments have been inaccessible to humans for most of our history, and even today are accessible only with the help of highly specialized equipment.

Filming, video, photography or audio recording that are not related to natural, historic, or cultural subjects of the Refuge is not covered under this CD (e.g., extreme sports photography, filming a movie unrelated to the Monument or Refuge mission, etc.). All recording proposals are anticipated to coincide with other projects for exploration, research, survey or scientific collecting; however, these scientific activities are considered in a separate CD. This CD only covers the acquisition of digital or photographic information and does not consider or include any sampling or specimen collections. Recording may be conducted in the Refuge benthic environments as long as it meets the criteria of being related to natural, historic, or cultural features. To ensure that the natural and cultural resources of the Refuge are protected, proposals must also specify how they plan to contribute to the achievement of the Refuge System mission and Monument and Refuge purposes.

Is the use a priority public use?

Yes

Where would the use be conducted?

Recording would be conducted within any benthic environment of the Mariana Arc of Fire NWR covering 46,780 acres of submerged lands. The Refuge includes the

following 18 units in the Philippine Sea, comprised of the submerged lands in a 1 mile radius from the center of each listed volcano or hydrothermal vent field. The Refuge includes unique geology, hydrothermal vent ecosystems, bottomfish habitats, and deep-sea coral and sponge communities. Vibrant groups of organisms thrive in these isolated benthic environments despite extreme pressure and heat, little to no sunlight, and toxic levels of dissolved metals and gases. Vent communities include squat lobsters as well as tubeworms, clams, and mussels that have developed a symbiotic relationship with chemosynthetic bacteria. The Refuge does not include the overlying water column. There are no USFWS facilities in this extreme environment.

Unit	Location	Summit Elevation
<b>Fukujin</b> (volcano)	143° 27'30" E, 21° 56'30" N	-712 ft
<b>Minami Kasuga 2</b> (volcano)	143° 38'30" E, 21° 36'36" N	-567 ft
<b>Minami Kasuga 3</b> (volcano)	143° 38'0" E, 21° 24'0" N	-3675 ft
<b>Northwest Eifuku</b> (volcano)	144° 2'36" E, 21° 29'15" N	-5035 ft
<b>Alice Springs</b> (hydrothermal vent field)	144° 70'73" E, 18° 21'03" N	-2.23 mi
<b>Central Trough</b> (hydrothermal vent field)	144° 45'0" E, 18° 1'0" N	-2.28 mi
<b>Zealandia Bank</b> (overlapping volcanoes)	145° 51'4" E, 16° 52'57" N	3 ft
<b>East Diamante</b> (volcano)	145° 40'47" E, 15° 56'31" N	-416 ft
<b>Ruby</b> (volcano)	145° 34'24" E, 15° 36'15" N	-754 ft
<b>Esmeralda Bank</b> (volcano)	145° 14'45" E, 14° 47'30" N	-141 ft
<b>Northwest Rota-1</b> (volcano)	144° 46'30" E, 14° 36'0" N	-1696 ft
<b>West Rota</b> (volcano)	144° 50'0" E, 14° 19'30" N	-984 ft
<b>Forecast</b> (volcano)	143° 55'12" E, 13° 23'30" N	-4816 ft
<b>Seamount X</b> (volcano)	144° 1'0" E, 13° 14'48" N	-4084 ft
<b>South Backarc</b> (hydrothermal vent field)	143° 37'8" E, 12° 57'12" N	-1.77 mi
<b>Archaeon</b> (hydrothermal vent field)	143° 37'8" E, 12° 56'23" N	-1.9 mi
<b>Pika</b> (hydrothermal vent field)	143° 38'55" E, 12° 55'7" N	-1.72 mi
<b>Toto</b> (volcano)	143° 31'42" E, 12° 42'48" N	-1.88 mi

### When would the use be conducted?

Recordings may occur any time of the year and for any bottom area of the Mariana Arc of Fire NWR. The USFWS in consultation with NOAA and others, as applicable, will evaluate each proposal and may put limits on the activities in an effort to ensure that negative impacts to resources are avoided or limited. All approved projects would be required to have a Special Use Permit (SUP). It is estimated that no more than 3 photography, filming, video, and audio recording SUPs would be issued in a calendar year.

## How would the use be conducted?

The use may be conducted by recording equipment attached to manned submersibles, remotely operated vehicles, or stationary observation systems. This equipment may have lighting adequate for navigation and illuminating subjects and provisions for luring marine organisms using bait.

All recording proposals are anticipated to coincide with other projects for exploration, research, survey or scientific collecting; however, these scientific activities are considered in a separate CD. This recordings CD only covers the acquisition of digital or photographic information and does not consider or include any sampling or specimen collections. Recordings of Refuge benthic environments may be conducted as long as they meet the criteria of being related to natural, historic, or cultural features. Recording proposals must also specify how they plan to contribute to the achievement of the Refuge System mission and Monument and Refuge purposes.

Recording projects involving video, filming, photography or sound would likely have different protocols and methods for recording the bottom environments and species of the Refuge as well as different strategies for reaching diverse audiences. Therefore, each proposal necessitates its own management review during the permitting process. Each project would be carefully reviewed to prevent any significant short-term, long-term, or cumulative impacts to Refuge resources. Proposals would be evaluated by USFWS staff, applicable partners at the NOAA, experts with the USGS, as well as other subject-matter experts as determined necessary by the USFWS. Evaluations and reviews would be conducted to determine if the species recorded, methods used, or habitat type and locations affected may lead to undesirable cumulative impacts. All projects would be required to have a Refuge Special Use Permit (SUP). This degree of review would help ensure numerous levels and types of impacts are carefully considered before any recording permit is issued. Within the SUP, conditions would be clearly defined to protect and conserve the existing resources found within the Refuge. Some of the standard and specific conditions are included in this CD under Stipulations Necessary to Ensure Compatibility.

Per Presidential Proclamation 8335, and relying on consultation between the federal agencies, nothing in this CD shall restrict scientific exploration or research activities by or for the Secretary of Commerce, and nothing shall be construed to require a permit or authorization for the Secretary of Commerce or his respective scientific activities.

## Why is this use being proposed or reevaluated?

This use has been reevaluated concurrently with the preparation of the Draft Mariana Trench Marine National Monument Management Plan and Environmental Assessment (USFWS 2020). Due to the extreme depths and sophisticated technological capability needed to access the Mariana Arc of Fire NWR; photography,

video, filming, and audio recording (“recording”) are the primary ways that the USFWS and others may gain access to and information about the area.

### **Availability of Resources**

Due to the complex nature of accessing the extreme depths and environments of the Refuge for recordings, only a handful of entities have the technology and capability to access their benthic environments. It is estimated that no more than three photography, filming, video, and audio recording SUPs would be issued in a calendar year. The bulk of the cost for this SUP is incurred in staff time to review proposals, coordinate with applicants, ensure recording activity contributes to the achievement of the Refuge System mission and Monument/Refuge purposes, write SUPs, oversee on-going projects, and review the project post-recording development and results. Law enforcement and dissemination of information about the projects in the Monument are not included in these cost estimates. We project that administering a single recording project SUP may require four weeks of intermittent staff time.

The protected area of the Refuge includes only the submerged lands and benthic resources of submarine volcanoes and hydrothermal vent fields; and does not include the overlying water column. Access to it is through remotely operated vehicles or manned submersibles. There are no USFWS facilities in this extreme environment. Permittees would pay the cost of all their actions related to the Refuge. Permittees working in the Refuge units would have to be self-sufficient for safely accessing the Refuge and would be required to obtain any additional permits needed for their actions. Any accidents or responses involving the permittees will be their sole financial responsibility. Any funds expended by the USFWS above general SUP administration, or as a result of an accident or response, will be reimbursed by the permittee. At this time, the Service does not require liability insurance or bonds for any filming activity. However, permittees would be liable for damages to Service resources during filming activities.

**Table 1. Annual costs to Administer and Manage photography, video, filming, or audio recording**

Category and Itemization	Recurring Annual Expenses
Staff time (LE, administration, and management)	\$4,700
Monitoring	\$4,600
<b>Total expenses</b>	<b>\$9,300</b>

*The numbers above reflect the estimated cost for three permits per year. Estimated costs were calculated using 5% of the 2022 base cost of a GS12/5 biologist, 2% cost of a GS13/5 Refuge Manager, and 5% of a GS7/5 biological technician assuming this use would use that “portion of a year” to administer.*

## Anticipated Impacts of the Use

### Potential impacts of a proposed use on the refuge's purpose(s) and the Refuge System mission

The effects and impacts of the proposed use to refuge resources, whether adverse or beneficial, are those that are reasonably foreseeable and have a reasonably close causal relationship to the proposed use. This CD includes the written analyses of the environmental consequences on a resource only when the impacts on that resource could be more than negligible and therefore considered an "affected resource." Water and air quality, geology and soils, floodplains, wilderness, environmental justice, and climate change will not be more than negligibly impacted by the action and have been dismissed from further analyses.

Most of the possible impacts recognized are over or within the water column, and therefore outside the boundary of the Refuge (the Mariana Arc of Fire NWR includes only submerged lands). These impacts may include: (1) disturbance of foraging sea birds and pelagic fish; (2) disturbance of marine mammals; (3) disturbance of endangered and threatened sea turtles; (4) release of pollution and contaminants; (5) disturbance and damage to fish, invertebrates, and algae.

Possible impacts to the bottom community of Mariana Arc of Fire NWR may include (1) disturbance to benthic marine organisms; (2) introduction of metals and other materials or equipment that are needed to travel to the bottom, and then discarded into the Refuge unit in order to return to the surface; and (3) accidental introduction of non-native extremophile species or contaminants from equipment used during the operations.

Each submarine volcano is likewise a submerged island of biodiversity. Each may hold unique biological communities from feature to feature and could potentially be susceptible to invasions by organisms that are not native to that feature. Possible impacts affecting the Refuge, or the water column and surface above the Refuge, include: (1) disturbance of foraging sea birds and pelagic fish; (2) disturbance of marine mammals; (3) disturbance of endangered and threatened sea turtles; (4) release of pollution and contaminants; (5) disturbance and damage to invertebrates and algae; (6) disturbance to benthic marine organisms; (7) introduction of metals and other equipment needed to travel to the bottom and then discarded in order to return to the surface; and, (8) accidental introduction of non-native extremophile species from equipment used during the operations.

Accidental introduction of non-native species between deep sites has been documented at other deep-sea locations. A submersible transferred 38 limpets from the Gorda Ridge at 7,457 feet depth to the Juan de Fuca Ridge after a 2-day journey of 394 miles. When the samples from this site were analyzed, the limpets were determined to be alive, having survived the time and depth of decompression and recompression between the two sites. As a precaution, permits will require disinfection

of hard equipment surfaces (i.e., with diluted bleach solution) before deploying to other locations.

Exploration vehicles can introduce vast quantities of single-use, plastic-coated tether that have been deliberately discarded as observed at the deepest site of all Earth's oceans. Manned submersible dives to Challenger Deep (10,925 m deep) in the Mariana Trench in 2019 and 2020 revealed hundreds of meters of yellow and white tether strewn across the seafloor (Vescovo et al. 2021). Due to its composition, these fiber-optic tethers will not only persist environmentally but form a significant risk to equipment and life should unmanned and manned craft become entangled. Therefore, the deliberate abandonment or discarding of nondegradable tethers is prohibited.

### Short-term impacts

Short-term impacts to refuge resources are expected to occur as a result of permitted activities. Anticipated short-term impacts include the disturbance of bottom sediments by submersible propellers that may impact nearby coral and sponge communities, the interaction with turtles and marine mammals in the water column above the Refuge, as well as the potential introduction of invasive species.

Incidental discharge of materials, oil, or ballast water from surface vessels or submersibles has the potential to impact threatened and endangered species that may be present at or near the ocean floor or passing through the water column above the Refuge. Since it is estimated that no more than three recording SUPs would be issued in a calendar year, the presence of vessels or submersibles would be intermittent and limited in duration. With adherence to US Coast Guard and IMO ballast water requirements, the Best Management Practices (BMPs) included within each SUP, and the stipulations contained herein, recording activities are expected to have a negligible, short-term impact to threatened and endangered species.

Bright lights on surface vessels above the Refuge units have the potential to impact seabirds if present. Seabirds may be attracted to bright lights at night, which could cause disorientation, disruption of migratory routes, and pose a collision risk with a lighted structure. Since no more than three recording SUPs would be issued per calendar year, the presence of vessels in or above the Refuge for recording would be intermittent and limited in duration. Vessels may be required to dim the lights every night, and those operating near seabird breeding islands and atolls at night would be required to black out all but the most essential lights. Coupled with BMPs included within each SUP, these stipulations would ensure bright lights from surface vessels would have a negligible, short-term impact to seabirds.

### Long-term impacts

Potential long-term impacts include damage to geologic features, corals and coral reef ecosystems, deep-sea hydrothermal vent and sponge communities, and other



benthic animal communities. Repetitive sedimentation could smother corals, causing stress and preventing reproduction and growth. Permittees will minimize these effects by photographing animals and bottom features at different areas in the Refuge units, minimizing multiple visits to one area. Damage done directly to coral animals can have long-term impacts on the survival of the animal. Invasive species may be introduced to the Refuge unintentionally from contaminated surfaces on the ROV or its components. A robust biosecurity plan must be approved prior to permitted activities to assure that long-term impacts from invasive species introductions does not occur.

## **Public Review and Comment**

The draft of this CD was included in the November 2020 Mariana Trench MNM Draft MMP/EA. The official public comment period for the MMP/EA was from February 24 – July 26, 2021. Comments were submitted to regulations.gov. The Draft MMP/EA was available on the web at multiple URLs including the Refuge Web pages. Hard copies were sent to public libraries in CNMI and Guam and available on request. A hard copy was also available at the Guam NWR Nature Center. In addition, FWS held four virtual public meetings in June 2021 to provide community-focused opportunities for the public to ask questions. Changes were made to the Draft CD in response to public comment, current guidance on the preparation of Compatibility Determinations, and current Department of the Interior and U.S. Fish & Wildlife guidance on the regulation of photography and other recording activities on National Wildlife Refuges and other public lands.

## **Determination**

Is the use compatible?

Yes

## **Stipulations Necessary to Ensure Compatibility**

1. Applicants for recording would be required to obtain a USFWS SUP. These permits may stipulate more detailed access restrictions and regulations to protect wildlife or Refuge integrity from anticipated site-specific negative effects caused by the project.
2. At the discretion of the Refuge Manager/ Superintendent, USFWS-approved staff may be assigned to accompany filming expeditions.
3. The USFWS encourages and supports compatible filming and photography in order to acquire information upon which decisions regarding management of

units of the Refuge System may be based and to provide access to this remote area to the public through the products of this work. Priority will be given to projects that contribute to the knowledge base of and management for biodiversity, enhancement, protection, use, preservation, and management of native wildlife populations and their habitat. Filming and photography must contribute to the achievement of the Refuge System mission and Refuge purpose (50 CFR 29.1).

4. In accordance with Department of the Interior filming regulations (43 CFR Part 5.1), utmost care will be exercised to see that no natural features are injured, and after completion of the work the area will, as required by the official in charge, either be cleaned up and restored to its prior condition or left, after clean-up, in a condition satisfactory to the official in charge.
5. Credit will be given to the U.S. Fish & Wildlife Service and the Department of the Interior through the use of an appropriate title or announcement (43 CFR Part 5.1).
6. Pictures will be taken of wildlife only when such wildlife will be shown in its natural state or under approved management conditions if such wildlife is confined (43 CFR Part 5.1).
7. Constant vigilance is kept for the presence of Federally listed species. When piloting vessels, vessel operators alter course to remain at least 100 yards from whales and at least 50 yards from other marine mammals and sea turtles.
8. Unless specifically covered under a separate permit that allows activity within proximity to protected species, all in-water work is postponed when whales are within 100 yards or other protected species are within 50 yards. Activity recommences only after the animal(s) depart the area. Should protected species enter the area while in-water work is already in progress, the activity may continue only when that activity has no reasonable expectation to adversely affect the animal(s); and no attempts are made to feed, touch, ride, or otherwise intentionally interact with any protected species.
9. Any special instructions received from the official in charge of the area will be complied with (43 CFR Part 5.1).
10. Any additional information relating to the privilege applied for by this application will be furnished upon request of the official in charge (43 CFR Part 5.1).
11. If the proposed methods would materially impact, appropriate, injure, destroy, or remove any Refuge resource, the permittee must identify the issues in advance. Highly intrusive or manipulative photography or recording is generally not permitted. As much of these recordings will be experimental due to the extreme environment, any non-anticipated disturbance would immediately be brought to the attention of the Refuge Manager/ Superintendent.

12. Permittees are responsible for acquiring and/or renewing any necessary additional permits prior to beginning or continuing their project.
13. Permittee would be responsible to cover all Refuge costs associated with the recording activity beyond what is predicted in this CD.
14. The Refuge Manager/ Superintendent or designated representative can suspend or modify conditions or terminate research that is already permitted and in progress should unacceptable, unforeseen, or unexpected impacts or issues arise or be noted.
15. Discarding or abandonment of non-degradable umbilicals from deep-sea exploration vehicles is prohibited.
16. Permittees will inspect all equipment prior to beginning work each day to ensure the equipment is in good working condition, and there are no contaminant (oil, fuel, etc.) leaks. All equipment found to be leaking contaminants must be removed from service until repaired.
17. All fueling or repairs to equipment must be done in a location with the appropriate controls that prevents the introduction of contaminants to the marine environment. Ship crews will prevent discharges of chemicals and other fluids dissimilar from seawater into the water column.
18. Permittees will follow the USFWS-provided Best Management Practices for Deep-Sea Research Marine Invasive Species Prevention or provide their own bio-security plan with their SUP application for review and approval to ensure that invasive species will not be inadvertently introduced into the Refuge.
19. All photography, filming, video, and audio recording permit holders would be required to submit an annual report to the Refuge Manager/ Superintendent that summarizes their activities for a given year and a final report when the project is completed. The report would include at a minimum the following: project title, SUP number, calendar year, progress, important findings, and problems encountered, proposed resolution to problems, preparer, and date prepared. The report and all publications and products derived from the SUP will appropriately acknowledge the activities were conducted with permission of the U.S. Fish & Wildlife Service under a National Wildlife Refuge System permit. Appropriate acknowledgment should also be given to the National Oceanic and Atmospheric Administration, when applicable. All reports, publications, or products will reference the Mariana Trench Marine National Monument.
20. Permittee must provide USFWS with at least one free copy of all products, commercial or otherwise, generated in the Refuge units for the non-commercial, governmental use of informing people about the Monument, Refuge, and the National Wildlife Refuge System.

## Justification

Photography, videography, filming, and audio-visual recordings in the Mariana Arc of Fire NWR are inherently valuable to the USFWS, governmental partners, and the public and are a necessary tool to further the aims of public education programs and public outreach as well as the primary method for gathering scientific information. The permitting of these pursuits supports the Presidential directive to study and protect this sensitive area. This is particularly true in this case where many of the resources remain undiscovered, unknown, and presumably in pristine or relatively pristine condition. By allowing recordings in conjunction with other uses (e.g., exploration, scientific collection, and surveys) proposed for the area we are encouraging a use that will have minimal impact but enormous reward in the form of information and inspiration. Thus, by effectively administering, tracking, and managing proposed uses through SUPs, the use would not materially interfere with or detract from the fulfillment of Proclamation 8335, the Refuge System mission, or the purposes for which the Refuge and Monument were established.

## Signature of Determination

*Tammy Summers* 7/27/2022

Refuge Manager Signature and Date

## Signature of Concurrence

Acting Regional Refuge Chief Signature and Date

## Mandatory Reevaluation Date

2037

## Literature Cited/References

Draft Mariana Trench National Monument Management Plan and Environmental Assessment, 2020.

Vescovo, Victor L., Jamieson, Alan J., Lahey, Patrick, McCallum, Rob, Stewart, Heather A., and Machado, Casey. 2021. Safety and conservation at the deepest place on Earth: A call for prohibiting the deliberate discarding of nondegradable umbilicals from deep-sea exploration vehicles, *Marine Policy*, Volume 128, 2021, 104463, ISSN 0308-597X. Available at: <https://doi.org/10.1016/j.marpol.2021.104463> (<https://www.sciencedirect.com/science/article/pii/S0308597X21000749>)