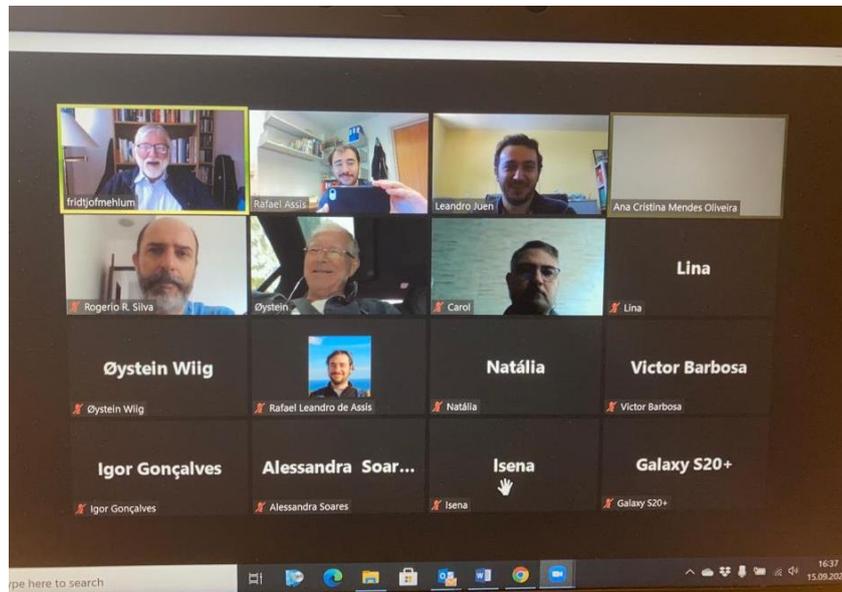


Annual Report 2021

The Biodiversity Research Consortium Brazil-Norway (BRC)



BRC remains very integrated and participatory despite the pandemic, and with increasing relevance in different media outlets. Above: BRC Scientific Committee members and observers during the September 2021 online meeting (Photo: Rafael Assis). Below: TV channel from Pará highlights the BRC project that assesses the return of birds to reforested areas (Source: "Jornal O Liberal").

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1. Introduction and background

The Brazil-Norway Biodiversity Research Consortium (BRC) conducts research on biodiversity and climate change in the Brazilian Amazon. Founded in 2013, the consortium is formed by the Federal University of Pará (UFPA), the Museu Paraense Emílio Goeldi (MPEG), the Federal Rural University of the Amazon (UFRA), the University of Oslo (UiO) and the Norwegian aluminum mining company Norsk Hydro (Hydro). The first contract of the BRC Consortium lasted for five years (2013 – 18), but was renewed for a new period of another five years (November 2018 to October 2023).

BRC is the result of a Hydro initiative. In 2012, shortly after taking over the aluminum operations of Companhia Vale do Rio Doce in Pará, Hydro contacted the Natural History Museum (NHM) of the University of Oslo. NHM was given the responsibility to facilitate the creation of a consortium for research cooperation based on the recommendations of the Hydro technical report entitled “Reforestation and Wild Animals Program - HYDRO Paragominas, Pará, Brazil”, by Salomão *et al.* (2012).

In the BRC Consortium agreement, the main objective of the cooperation is “to develop applied and basic research activities, and build a solid base of results in biodiversity and climate knowledge” among the partners. The consortium should also contribute to “increasing the university-industry partnership”. In addition to joint research and publications, “post-graduation (master's and doctorate) will be an important element of the consortium's activity”.

This annual report is prepared by the BRC secretariat. It presents the main results and activities of the consortium in 2021. In the final section, important lessons learned are presented. We refer to the minutes of the meetings of the Council and Scientific Committee of the BRC and reports of specific events for the preparation of this report.

2. Main results 2021

In 2021, BRC made substantial progress in all of the defined objectives - research, partnerships and student engagement – as well as in the long-term sustainability of the consortium. In addition, BRC also made progress in terms of communication between all parties involved in the consortium. These achievements occurred despite all the challenges faced by the Covid-19 pandemic. The main results in 2021 were:

- As 2020, the year 2021 had a high number of publications in scientific journals, with about 10 articles published/accepted for publication;
- Strengthening communication between the parties involved in the consortium, which is of great importance for the discussion and resolution of issues of common interest;
- Promotion and realization of various events between research groups (e.g. webinars), seminars on BRC projects and professional development activities (e.g. academic courses);
- The relevance of BRC has been recognized by other (non-academic) dissemination media, resulting in greater access by the general public to the results of BRC projects;
- Significant increase in the number of students supported by BRC, both for undergraduate and graduate students, highlighting the importance of the consortium for the institutions involved and for the science developed in the region;

- Researchers from BRC have developed a framework for the biodiversity indicators, a starting point for further development of operational recovery indicators. This document will potentially be the first protocol of this kind applied for post-mined areas in the Amazon;
- Support from Hydro has been crucial for research leaders maintaining their scientific activities and staff (including students) during times of pandemic;
- The prospects of re-establishing field activities in the near future, with preparations and training for the resumption, gives rise to optimistic expectations for the progress of BRC projects in the next year.

3. The BRC Board

The BRC board is composed of a representative from each institution participating in the consortium. In 2019, the members were: professor Marcos Piedade (UFRA), professor Alexandre Bragio Bonaldo (MPEG), professor Leonardo Sena (UFPA), Domingos Campos (head of HSE - Hydro) and Fridtjof Mehlum (senior researcher - UiO). Leonardo Sena (UFPA) served as chairman of the board.

The Board held its annual meeting on March 17, 2021, by video conference. The approval of the BRC Strategic Plan (2021 – 2031), as well as the role of BRC in social networks to improve the dissemination of BRC activities and products, and the implications of the pandemic for the progress of BRC projects, were some of the topics discussed during the meeting.

4. The BRC Scientific Committee

The Scientific Committee (SC) of the BRC makes all scientific and operational decisions in general. It is composed of two representatives from each member institution and normally meets twice a year. In 2021, the committee members were: professors Lina Bufalino and Norberto Cornejo Noronha (UFRA), researchers Alberto Akama and Rogerio Rosas Silva (MPEG), professors Ana Cristina Mendes de Oliveira and Leandro Juen (UFPA), Patrick Brading (environmental manager - Hydro), Domingos Campos (head of SMS, Hydro), senior researcher Fridtjof Mehlum and professor Øystein Wiig (UiO).

The Scientific Committee had two meetings in 2021, both of which took place as video conferences. The first took place on March 16th. Fridtjof Mehlum (UiO) chaired the meeting. The following members were present: Rafael Assis (UiO/BRC), Øystein Wiig (UiO), Fridtjof Mehlum (UiO), Ana Cristina Oliveira (UFPA), Patrick Brading (Hydro), Norberto Noronha (UFRA), Leandro Juen (UFPA) and Rogério Rosas Silva (MPEG). The main topics discussed were related to the challenges faced by the team as a result of the pandemic. Among them, Hydro updated the team on how the company has acted to proceed with its operations in order to prevent further spread of the virus, the status of all BRC projects at the time of the pandemic, possibility of project extension and budget changes due delays, and the prospects of when projects can restart their field activities. SC members were also updated on the status of the initiative related to Biodiversity Indicators, progress in the preparation of the BRC book, and discussed how the results of the BRC studies can be better applied to Hydro's plans for more sustainable operating practices in the areas mining.

The second meeting took place on September 15th (Figure 1). Participants were: Rafael Assis (UiO/BRC), Fridtjof Mehlum (UiO), Øystein Wiig (UiO), Leandro Juen (UFPA), Ana Cristina Oliveira (UFPA), Patrick Brading (Hydro), Domingos Campos (Hydro), Lina Bufalino (UFRA), Norberto Noronha (UFRA), Alberto Akama (MPEG), Rogério Rosas Silva (MPEG). Other BRC members participated as observers. Fridtjof Mehlum (UiO) chaired this meeting. Professor Lina Bufalino replaced Professor Gracialda Ferreira as one of UFRA's representatives on the committee. Professor Ferreira has temporarily left UFRA to take up a position at the Institute of Forestry and Biodiversity Development (Ideflor-Bio). Professor Ferreira has been with BRC since its start in 2013, and the consortium recognizes and thanks her for the great effort that she has made to BRC. Some of the issues addressed at the meeting were: updates on Hydro's operations to face the pandemic, including prospects for projects to restart fieldwork; status of all projects in times of pandemic; updates on project extensions and budget changes; status of the Biodiversity Indicators initiative; publication of the BRC book; BRC's partnership with Hydro's communications team.

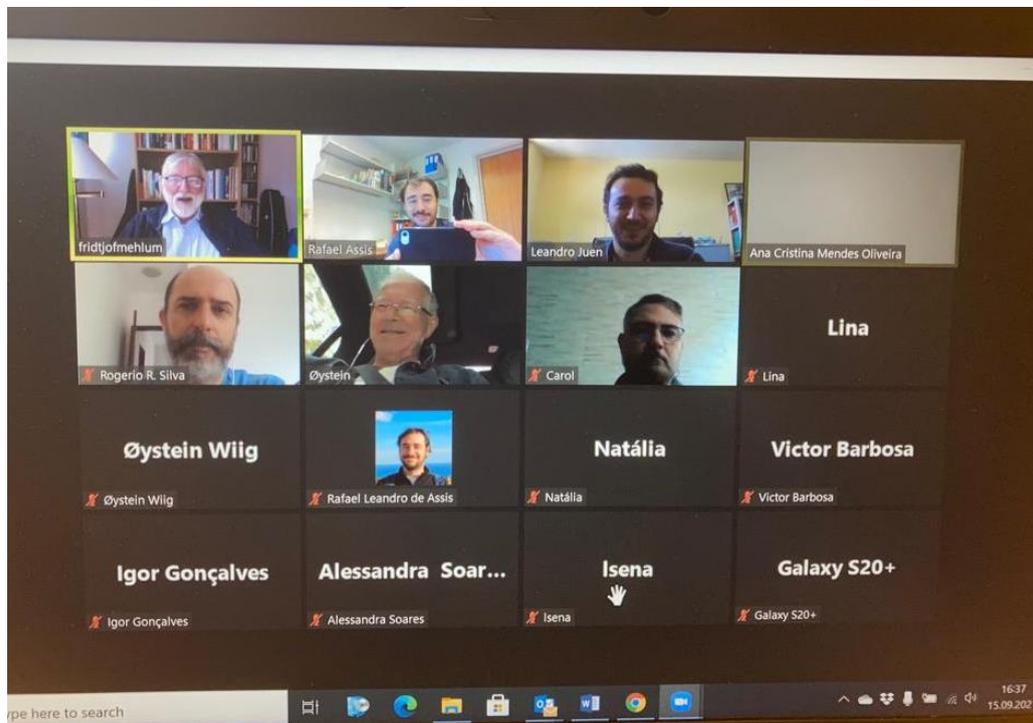


Figure 1. BRC Scientific Committee members and observers during the online meeting, in September 2021.

5. The BRC Secretariat

The BRC secretariat is responsible for coordinating the activities of the consortium and for preparing and planning Board and Scientific Committee meetings. It is also responsible for coordinating project submission processes, fundraising initiatives, as well as internal and external communication. It is headquartered at the NHM in Oslo and led by Dr. Rafael Leandro de Assis.

The current contract of Rafael Assis as head of the BRC secretariat expires in March 2022. In November 2021, Rafael was offered an extension of his contract (until November 2023), which was rapidly accepted.

6. Research project activities

In 2021, most of the BRC projects from the last call for new projects (2019) had their contracts signed, their budget released and are already underway. The exception is the BRC 17/19 – “*Metabarcoding and metagenomics for high throughput inventory and monitoring of terrestrial arthropod biodiversity*”, which still needs its contract to be agreed between the Norwegian counterpart of the project (Vladimir Gusarov – UiO), and Hydro.

Although most projects are ready to start, few of them made substantial progress due to the inability to carry out field activities for much of the year. The project leaders concentrated their efforts on assembling their teams for the projects (students, postdocs, etc.), as well as acquiring equipment for the experiments/field work, among other activities related to the research projects. Delays caused by the pandemic, and demands related to financial adjustments (mainly caused by the devaluation of the Real against the Dollar, increasing costs for reagents and equipment) have impacted several projects’ budgets. In face of this scenario, Hydro has made adjustments to the previously proposed budget for some of these projects.

Therefore, most of the BRC projects of this last call, as well as those of the previous calls, are already in full operation (Annex 1). However, field work had been suspended during the whole year (2021) because of the pandemic. Progress reports were presented twice a year to the BRC Scientific Committee. Only one of the projects listed in Annex 1 however, has not yet started - BRC 15/17 (The *Topsoil* project). The reason is that there has been a change in funding to support this research. It was anticipated that this project would be financed by external funds, but in the end no external funds were obtained. However, discussions between the project coordinators and Hydro to find a solution were very productive and a new budget is being prepared.

Some other administrative issues also remained pending throughout 2021, mainly involving the processing of accounts for projects that had their contracts concluded in 2020, but did not use all the available funds. In total, six projects fall into this category, including BRC 01/14 – “*Arbuscular mycorrhizal fungi in natural areas and areas in restoration after bauxite mining in Pará*”, BRC 11/15 – “*Diversity of the herbivorous insects in four areas of the Hydro mining company*”, BRC 13/16 – “*Tracking jaguars in the Hydro bauxite mine area in Paragominas, Brazil*”, and others. The secretariat is in constant contact with those responsible for administrative procedures at Hydro, together with project leaders, aiming to resolve this issue as soon as possible.

As for scientific production, the year 2021 was another very productive year in terms of the number of articles published. These publications covered a large number of research topics: forest restoration, aquatic and terrestrial insects, seedling production, aquatic plants and many others. Below are some highlights of publications:

- a. we now have a better understanding of how environmental gradients influence morphological and phylogenetic characteristics of some groups of aquatic insects (“BRC0026 – *Morphological and phylogenetic factors structure the distribution of damselfly and dragonfly species (Odonata) along an environmental gradient in Amazonian streams*”, Bastos et al. 2021 – Ecological Indicators) (Figure 2);
- b. we have now improved techniques combined with natural regeneration that can be more efficient for restoration of post-mining areas (“BRC0032 – *Natural Regeneration for restoration*

of degraded areas after bauxite mining: a case study in the Eastern Amazon”, Brasil-Neto et al. 2021 - Ecological Engineering);

c. Another publication that deserves to be highlighted is a product originated from the field course in Tropical Ecology, edition of 2018. Students of the course together with involved professors published the article “BRC0027 – *The role of macrophyte architecture in driving periphytic algal communities in the lowland river in the Brazilian Amazon*, Leão et al. 2021 - Brazilian Journal of Botany);

d. Another relevant publication came from the group of academics involved in the project BRC 12/16: “*How ecological interactions are influenced by mining activities and efforts for environmental restoration after exploration in the municipality of Paragominas*”. They published a still poorly documented methodology on collecting arboreal arthropods from treetops via foliage agitation (“BRC0022 – *Collecting arboreal arthropods a technique for sampling plant-inhabiting arthropod communities in a tropical forest*, Viana-Junior et al. 2021 - Entomology Experimentalis et Applicata) (Figure 3).

The list with all BRC publications is in Annex 2. These studies, among all others, are very important to increase knowledge of the most diverse biome on the globe, and reveal that there is still a lot to be known about the flora and fauna of the Amazon, as well as better understanding how to minimize the impact on the environment caused by the exploitation of natural resources. The results are also very relevant as a scientific basis for greener practices in an attempt to ensure more sustainable exploration in the region. In addition, the high number of publications reveals that some of the consortium's most important objectives, which is the development of research activities and the strengthening of the university-industry partnership, are being achieved.

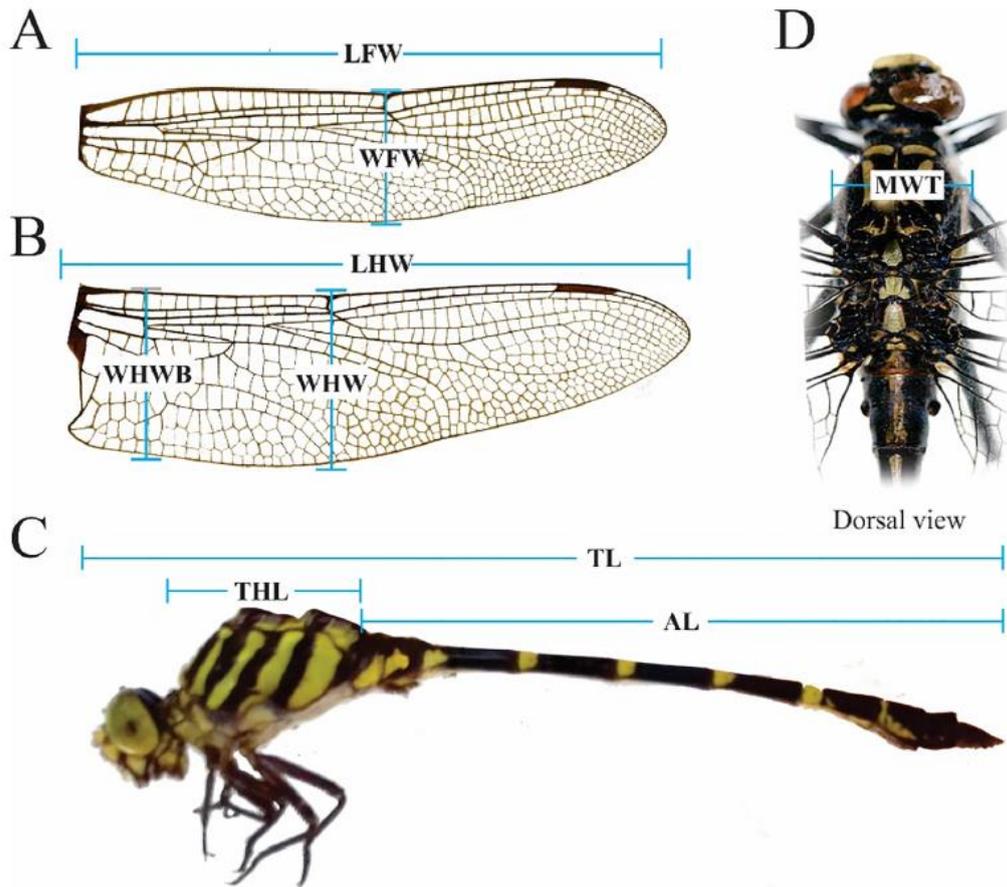


Figure 2. BRC researchers studied the morphological and phylogenetic response of dragonfly species to environmental gradients. (Image: *Ecological Indicators*).

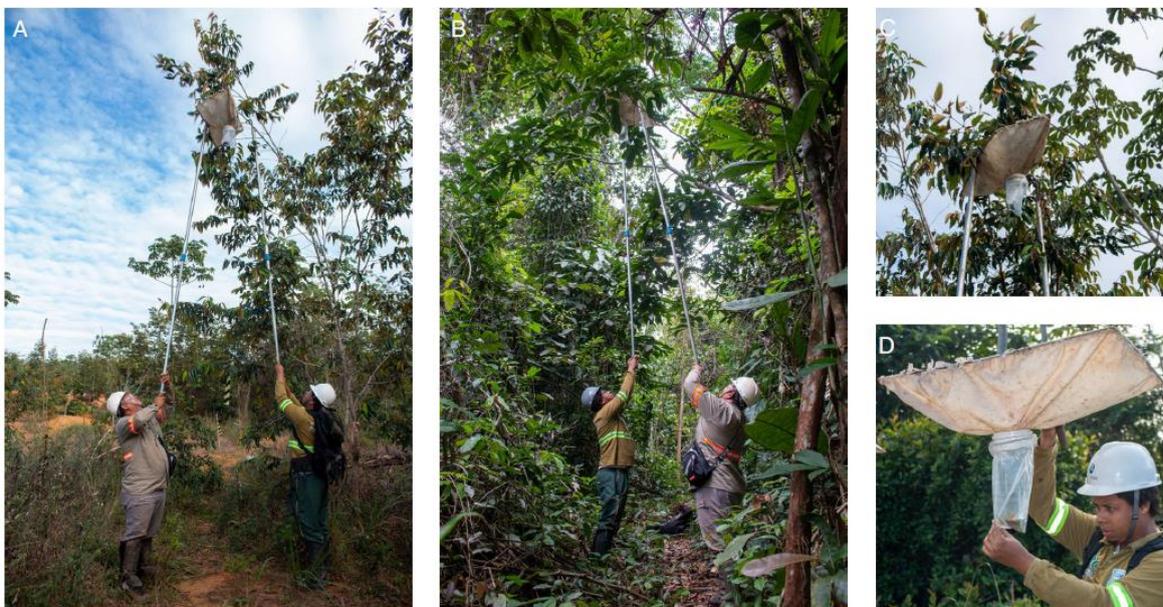


Figure 3. Foliage shaking technique for arthropod collection in operation in the Hydro Paragominas area. (A) natural regeneration area, (B) forest area, (C) collection tray detail and (D) collection bag detail after shaking the foliage. (Photo: César Favacho).

7. Partnership between BRC and Hydro's communication team yields numerous articles in newspapers and television

BRC increased its relevance with regard to the dissemination of its actions and research projects during the year 2021. There were several articles published in print newspapers and digital media, in addition to television reports. Part of this success is due to the closeness of the BRC coordination with the Hydro communication team. The two parties started having monthly meetings since June 2021 to discuss potential agendas for the dissemination of material, which yielded numerous articles that were published. In the following lines, some examples that were highlighted.

On August 7, an article in the newspaper “O Liberal” was aired, highlighting the return of bird species to reforested areas in the Hydro area. The article highlighted results related to the project BRC 08/15 – *“Bird diversity in three areas in different states of conservation in the Eastern Amazon”*, coordinated by professor Marcos Pérsio (UFPA).

Also, news about the initiatives on forest restoration and biodiversity recovery conducted by BRC in Paragominas was broadcasted on TV (“SBT Pará”). The report was mainly focused on the return of bird species to the previously degraded region, and included an interview with the professor Marcos Pérsio (Figure 4).

On July 21st, the newspaper “Diário de Belém” published a report on Hydro's efforts to reforest the mining area in Paragominas, highlighting the research carried out by the BRC Consortium. The report also highlighted the role of the BRC in the region, stating that the initiative *“began in 2013, with the creation of the Brazil-Norway Consortium for Research in Biodiversity, with researchers from UFPA, the Goeldi Museum, UFRA and the University of Oslo, in Norway”*.

Another local publicity that took the name of the BRC came out in an *online* article in the newspaper “O Liberal” about the Forest Engineer's Day, celebrated on July 12th. (Figure 5). The article highlighted the importance of these professionals for forest restoration programs and included interviews with some of them. Among them, Igor do Vale, a forestry engineer employed by Hydro and responsible for the technical specifications for the rehabilitation of the mined areas in Paragominas. The article also featured interviews with the engineer Suany Couto, who developed her master's thesis associated with one of the BRC projects (BRC 03/14 – *“Biodiversity, proliferation of plant species and restoration of degraded areas from bauxite mining in the southeast region of Pará”*), coordinated by professors Marcos Piedade Gama and Gracialda Ferreira, both from UFRA.



Figure 4. Pará's local news channel presented some of the ongoing studies in Paragominas with the support of the Hydro – BRC collaboration. Among the highlights of the article, the project that assesses the return of birds to reforested areas was mentioned.

Hydro amplia seus esforços de reflorestamento em Paragominas



Em 2020 a Hydro preparou mais de 88 mil mudas para o reflorestamento de áreas mineradas em Paragominas.

Com o reflorestamento de um total de 2500 hectares, extenso equivalente a 2500 campos de futebol, a mina de bauxita da Hydro no sudeste do Pará ampliou sua área reabilitada. Somente em 2020, foram recuperados 206 hectares, área 52% maior em relação ao ano anterior na Mineração Paragominas. Essa evolução excedeu as expectativas, mesmo em um cenário de pandemia.

A empresa cumpre e segue a meta de reflorestamento 1:1, ou seja, a cada 1 hectare de área lavrada é recuperado 1 hectare em até dois anos após sua disponibilização. Com esses números, que levam em conta os ciclos da mineração, é possível alcançar uma atuação sustentável com a conservação do ecossistema local graças ao avanço das técnicas de reabilitação e à segurança operacional da mina.

Cerca de 70% do reflorestamento é realizado com a técnica de nucleação, enquanto 30% é feito com o plantio tradicional. A nucleação consiste na formação de "ilhas" ou núcleos de vegetação com espécies com

capacidade ecológica de melhoras significativamente o ambiente, facilitando a ocupação dessa área por outras espécies. As espécies usadas na recuperação das áreas da Mineração Paragominas são referenciadas no inventário feito pela empresa, antes da extração do minério, com aproximadamente 50 espécies adaptáveis à realidade da região. Dentre as espécies, no ano passado, foram plantados ipê amarelo e roxo, jatobá, maçaranduba, ingá de macaco, abiti de macaco, mata-mata e fava bolota.

As mudas são cultivadas no viveiro da Mineração Paragominas que, em 2020, produziu mais de 88 mil mudas. Elas são provenientes de sementes e mudas coletadas na área florestal da empresa e seu entorno.

Apoie sua ciência e saiba mais sobre os esforços de sustentabilidade da Hydro:



Figure 5. "O Liberal" newspaper from Pará presented a report on Hydro's efforts to reforest the mining area in Paragominas, highlighting the research carried out by the BRC Consortium.

8. BRC researcher wins “Women in Science 2021” award

Professor Thaísa Michelan, UFPA and BRC, was one of the seven winners of the 16th edition of the “Women in Science” program of the L’Oreal Foundation, in the Life Sciences category (Figure 6). For 16 years, L’Oréal Brasil, in partnership with UNESCO in Brazil and the Brazilian Academy of Sciences (ABC), has been promoting the “For Women in Science” program, with the objective of transforming the scientific scenario, contributing to the evenness of gender in the area. Statistical models to monitor the new coronavirus pandemic, study of climate change, restoration of the biome and the connection between the health of the environment, animals and human beings are some of the objectives of the winning works of the 2021 edition.

Thaísa Sala Michelan, from the Laboratory of Ecology of Primary Producers and the Graduate Program in Ecology (PPGECO - UFPA) is coordinator of the BRC project BRC 26/19 – “*Effects of land use on diversity and ecophysiology of riparian vegetation, macrophytes water and plankton in streams and ponds in mining areas*”, and collaborates with BRC since 2016.



Figure 6. Professor Thaísa Michelan, winner of the 16th edition of the “Women in Science” program at the L’Oreal Foundation, in the Life Sciences category.

(Source: <https://pt.unesco.org/news/unesco-loreal-e-abc-divulgam-sete-vencedoras-do-programa-mulheres-na-ciencia-2021>).

9. Challenges Faced by the Pandemic

The year 2021, like 2020, will forever be remembered as the year of the Covid-19 pandemic. Several sectors of society were deeply impacted by the pandemic, from industries to segments that include travel agencies, services and businesses in general. Similarly, the sector involving academic institutions also suffers its consequences. With regard to the BRC projects, all had to stop fieldwork in mid-March 2020 and could not resume activities until the end of 2021. Laboratory activities were also severely impacted by the pandemic.

Despite the difficulties that research groups have been facing in the face of the pandemic, BRC managed to continue several research activities. This was possible mainly thanks to the virtual platforms: they hosted the meetings between the members of the consortium, allowing them to work from home and avoid further exposure to the virus. Thus, important and crucial events for the maintenance of the dialogue between the partners and for important decisions within the consortium were carried out following the previously planned schedule. Thus, all events throughout the year were held online, such as the board and scientific committee meetings, BRC internal seminar, courses and other meetings.

In addition to fulfill the schedule of important meetings for the consortium, the BRC also adopted strategies to approach research leaders and offer them the necessary assistance. One example was the monthly meetings, which began in June 2020 and continued throughout 2021. These meetings were very important to update participants on the situation and challenges caused by the pandemic, including issues of health, changes in the field work schedule, support to students and other employees, safety protocols, among others.

The monthly meetings were also very important for discussing other topics of great importance to the consortium, such as the progress of the Biodiversity Indicators initiative and the BRC book. Through monthly meetings, participants were also able to update themselves on new publications, events and opportunities. Finally, these meetings have been crucial for participants to share experiences and other concerns they faced due to the pandemic and to seek appropriate solutions.

The progress of all BRC projects in general has been impacted and consequently all projects are delayed. However, there is great expectation of resumption of field activities as early as the beginning of 2022. To facilitate this resumption, and speed up the restart of projects whose demands are delayed, Hydro took the “recycling” course to Belém (work safety course to work in mining areas, generally provided in Paragominas). This course, mandatory for anyone entering the mine area, was offered to all BRC members and lasted for three days, between November 3rd and 5th. In total, around 70 people attended the course, taught at UFPA (face-to-face format). A new version of the course is planned for January 2022, to those who were unable to attend the course given in November 2021.

Finally, it is worth mentioning the administrative/financial support that the company Hydro has been offering to all project leaders, in order to prevent these delays from affecting the quality of their studies. In this context, Hydro has been flexible in helping solving the problems encountered by the projects, and is considering adjusting the schedules and budgets of the projects. This confirms the solid partnership that has been built between Hydro and the research groups, and the willingness to support the studies so that they achieve the goals initially proposed. In addition, there was a great concern with measures to protect the health status of students and BRC employees. From the beginning of the pandemic, the well-being of all participants was considered the first priority, and all partners were very transparent in communicating measures to contain the spread of the virus. It has been highly important to show all BRC members that health is a major concern and that activities will be resumed only when the safe conditions are guaranteed for everyone.

10. Promoting Web Seminars and Online Events

Although the pandemic hampered most of the scientific activities scheduled for the year, BRC researchers arranged several online events to disseminate the results, initiate discussions related to a wide range of topics, integrate students and teachers, and also to encourage the dissemination of science during pandemic times. These webinars happened by all means, especially social media.

Due to the need for social distancing, and with several professionals working from home, this platform was extremely important throughout the year. Researchers, scientists and teachers used this form of communication to get closer to students and the general public. Likewise, researchers associated with the BRC hosted webinars and other online events and together were able to reach hundreds of listeners and observers.

An example of a webinar organized by researchers linked to BRC was arranged by Prof. Jonathan Ready (UFPA), with the theme focused on the use of environmental DNA as a technique for surveying biodiversity and biomonitoring (Figure 7). Entitled “Amazon DNA”, this webinar was used to discuss aspects related to the project “BRC 16/19 – *“Measuring biodiversity dynamics”*”, led by Prof. Ready and supported by the BRC.

The online platform was also very important to expand BRC’s relevance and reach audiences from different regions for postgraduate thesis defense events, both master's and doctoral degrees. Several students who developed their work within BRC projects provided an online public defense. Two examples were the master student Myllena Lima and the doctoral student Sidiane Castanhêde (Figure 8A and 8B), both from the Postgraduate Program in Aquatic Ecology and Fisheries at UFPA. The first was a student of Prof. Leandro Juen and carried out research with the project BRC 10/15: *“Aquatic biota monitoring of streams in mining areas of Paragominas SA, Pará, Brazil”*; the second was a student of Prof. Lilian Amado and Prof. Luciano Montag and developed her project in BRC 19/19: *“Use of native species from different trophic levels and occurring in bauxite mining area to evaluate the toxicity of residues derived from this activity”*.

These events were of paramount importance to disseminate science, bring together students and other interested parties to discuss the scientific themes developed at BRC, as well as to increase the relevance of the consortium's studies. During the pandemic, these events helped students to keep up-to-date on topics related to a wide range of science subjects. They were also important to help students stay at home and still access important information sources for their training and development as researchers.

Webinário: DNA da Amazônia

Guilherme Oliveira, Instituto Tecnológico Vale (ITV): A genômica como base para a conservação das espécies e geração de renda

Prof. Dr. Jonathan Ready, Universidade Federal do Pará (UFPA): Perspectivas de eficiência e sustentabilidade na genômica ambiental

Leticia Guimarães, Vale: Importância das pesquisas sobre genoma para conservação da biodiversidade da Amazônia no contexto da mineração

Dia 20 de julho, das 10h às 11h30. Inscreva-se agora!

INSTITUTO TECNOLÓGICO VALE

Figure 7. Online event presented by Dr. Jonathan Ready (UFPA and BRC) and colleagues, about the importance of Metabarcoding biodiversity and conservation in Amazonia.

A

APRESENTAÇÃO PÚBLICA DE MESTRADO

MUDANÇAS NO USO DA TERRA ALTERAM OS RIACHOS E AFETAM OS GRUPOS FUNCIONAIS ALIMENTARES DE INSETOS AQUÁTICOS NA AMAZÔNIA

Discente: Myllena Lima
Orientador: Leandro Schiemmer Brasil
Co-orientador: Leandro Juen

27 de Fevereiro de 2021 às 09:00hrs Apresentação on-line (google meet)

B

DEFESA DE TESE

Biomarcadores de poluição aquática em peixes de riachos da Amazônia Oriental

Doutoranda Sildiane Cantanhêde

26 de Fevereiro de 2021

Às 14 horas

<http://bit.ly/defesasildiane>

Orientadora: Profa. Dra. Lílian Lund Amado
Co-orientador: Prof. Dr. Luciano Fogaça De Assis Montag

Figure 8. Online events with master's and doctoral defense of students who developed projects with BRC. MSc. Myllena Lima - UFPA (left - 8A), and Dr. Sildiane Castanhêde - UFPA (right - 8B).

11. Field Course in Tropical Rainforest Ecology and Biodiversity

The field course is carried out by the partner institutions of BRC and is part of the graduate programs of the participating institutions. Funding for the course was obtained from the Norwegian Center for International Cooperation in Education (DIKU), during the UTFORSK call, and would fund the course for four years (2018–2021). The course includes two parts: one in Brazil and one in Norway. In the first part, eight students from Norway (NMBU and UiO) travel to Brazil and join eight students from Brazilian institutions (UFRA, UFPA and MPEG) for fieldwork in the Amazon

rainforest. For the second part, they go in the opposite direction: students from Brazil travel to Norway and work together with students from Norwegian institutions.

So far, the field course has been held twice: 2018 and 2019. However, due to restrictions and concerns caused by the pandemic, the course for 2020 and 2021 were cancelled. Fortunately, the agency responsible for funding the course (DIKU - UTFORSK) accepted the justification of postponing the course for one year. Therefore, the course will be offered for at least one more year (2022). According to the initial proposal, the course would have its last edition in 2021.

We are optimistic that the situation will be better next year, to offer another field course in August-September 2022. This initiative is very important for our objectives of exchanging students and teachers between the two countries, as well as for strengthening collaboration between institutions and research groups.

12. Special Issue of the MPEG Bulletin on “Biodiversity and Ecological Restoration Processes Related to Mining Areas”

In December 2020, the BRC together with MPEG opened a call for papers to be included in a special edition of the Bulletin of the Museu Paraense Emílio Goeldi - Natural Sciences with the theme “*Biodiversity and Ecological Restoration Processes Related to Mining*”. The idea is to gather research articles that address the topic of biological diversity in areas influenced by mining, as well as its conservation, recovery and sustainable use. The mission of this special edition is to promote and disseminate knowledge not only about the concept of sustainable development in mining areas, but also specialized knowledge through ecological research results in the area of biodiversity restoration. Articles will also be published on scientific methods for mitigating impacts and recovering those influenced by mining.

However, although the final date for submission was June 2021, the minimum number of articles for the production of the special volume was not reached. This low response is mainly due to implications caused by the pandemic, which significantly compromised the scientific production of research groups. Consequently, a new deadline for submission was established: December 31st, 2021. It is expected though an extension of this deadline, but the new date is yet to be set. The publication of the volume is scheduled for June/July 2022.

For the dissemination of the theme and call for manuscripts, social media platforms and websites were used (MPEG, BRC, etc.) (Figure 9).



Figure 9. Folder for promoting submission of papers to the special edition of the MPEG Bulletin on “Biodiversity and Ecological Restoration Processes Related to Mining Areas”, an initiative between MPEG and BRC.

13. Course on Recovery of Degraded Areas

In early 2021, BRC and UFRA's Forest Engineering Tutorial Education Program organized the “*International Course for the Recovery of Degraded Areas: (Re)Building the Past*”. The course aimed to provide theoretical and practical training on concepts, legislation and application of methods for planning and executing forest restoration activities, strengthening the debate on the subject. Its objective is to expand knowledge on the subject, collaborating with actions under development in the Amazon region and, therefore, contributing to the technical training of professionals in the area. Among the topics covered were: steps generally involved in forest restoration processes, such as the most suitable methods, legislation, techniques to promote the return of natural elements and environmental services.

The course brought together professors from various disciplines who work in the area of forest recovery, mainly in the Amazon. It was taught for two and a half weeks (January and February 2021), with remote classes and offered entirely on a virtual platform (Figure 10).

As the course was conducted over the internet (*online*), the possibility of participation of people from different regions of the country opened up. By the end of the application period, more than 50 people had applied, from over twenty different institutions and cities, spanning six different states in Brazil. The professional profile of those enrolled was very diverse, including biologists, forestry and environmental engineers, agronomists, among others.

In the end, the course was a success. Many of the students participated in the final evaluation of the course and the vast majority highlighted the importance of the learning obtained,

and attributed excellent course evaluations, as well as great suggestions for improvement. BRC together with the UFRA team intend to offer the course once again in the first semester of 2022.

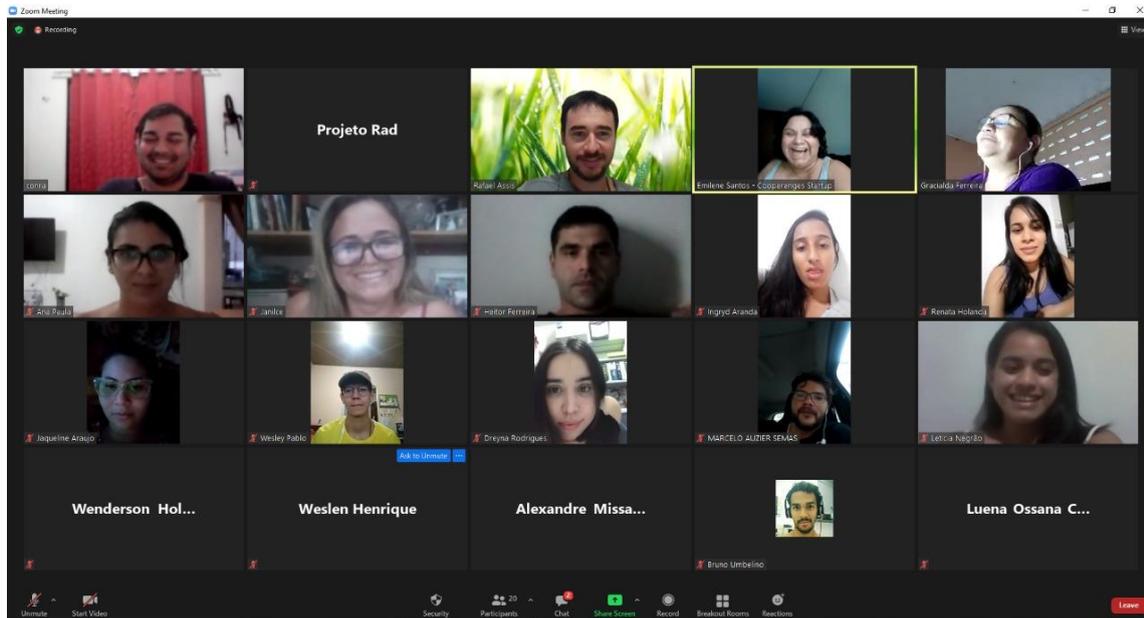


Figure 10. Students and teachers during the virtual course on Recovery of Degraded Areas, organized by UFRA and BRC.

14. Internal Seminar on BRC Projects

The secretariat organized another Internal Seminar event on projects supported by the BRC, held on September 14th, 2021. The event was held via an online platform (*webinar*), and its main objective was to discuss and disseminate results and experiences of BRC projects. Approximately 100 people, including students, professors and members of the general public, attended the Seminar.

Many of the BRC project leaders held presentations (Figure 11). Themes were diverse, such as Metagenomics and Metabarcoding (Prof. Jonathan Ready), use of insect species as restoration indicators (Prof. Rogério Silva), biodegradation of stocked wood and its effects on the environment (Prof. Lina Bufalino), and Monitoring of terrestrial mammals via trap cameras (Prof. Ana Cristina Oliveira (Figure 12).

In addition to the project leaders, many students presented the work they have been developing with BRC projects. This was the case of postdoctoral students Mônica Coelho and Poliana Lemos of Prof. Leonardo Sena, leader of the project BRC 18/19 – “*Metagenomic and metabarcoding as a tool for developing One Health in Hydro Area, Paragominas, Pará, Brazil*”. In addition to these, master's student Leilane Bezerra also presented her work developed with the project BRC 12/16 – “*How ecological interactions are influenced by mining activities and efforts for environmental restoration after exploration in the municipality of Paragominas*”, coordinated by Prof. MarluCIA Martins. BRC supports and encourages the participation of students from its projects in events organized by the consortium.

BRC PROJECTS SEMINARS 2021

PROGRAM

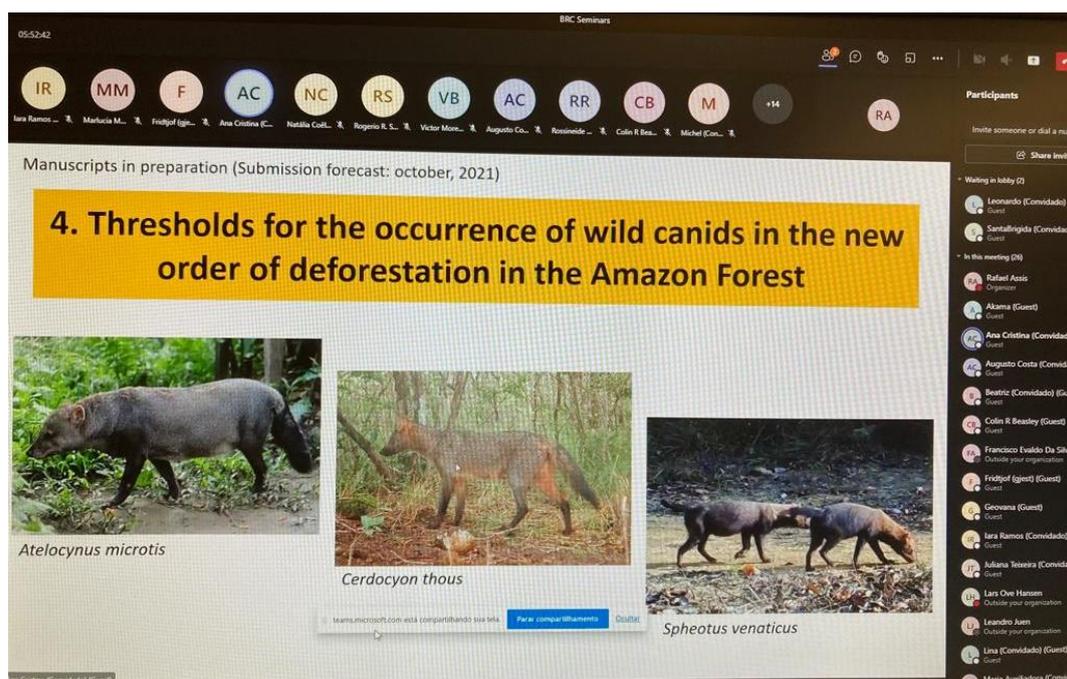
- ▶ BRC 16/19 and Associated Projects (CAPES-UTFORSK and SAMBA) - Dr. Jonathan Ready
- ▶ Metagenomic and Metabarcoding as a Tool for Developing One Health in Hydro Area- Mônica Coelho and Poliana Lemos
- ▶ Entomological Survey and Indicator Species for Forest Restoration - Dr. Rogério Silva
- ▶ Ecological Interactions in Post-Mining Regeneration Areas - Dr. Marlúcia Martins
- ▶ Floral Biology of *Gouania Cornifolia* (Rhamnaceae) in Post-Mining areas - Leilane Bezerra
- ▶ Distribution Pattern of Aquatic biota at Hydro Paragominas - Dr. Luciano Montag
- ▶ Monitoring Terrestrial Mammals by Cameras Trap in the Hydro area - Dr. Ana Cristina Oliveira
- ▶ Coexistence Plan for Human and Carnivores in Paragominas - Iara Ramos
- ▶ Biodegradation of Stored Tropical Wood and its Effect on environment - Dr. Lina Bufalino
- ▶ Biodiversity indicators for Programs of Recovery of Degraded Areas (PRAD) in the Amazon, with an emphasis on bauxite mining - Dr. Ana Cristina Oliveira








Figure 11. Program of seminar event on BRC projects organized online in September 2021 (Artwork: Rafael Assis).



4. Thresholds for the occurrence of wild canids in the new order of deforestation in the Amazon Forest



Atelocynus microtis



Cerdocyon thous



Speoteus venaticus

Figure 12. Online presentation of the project “Monitoring of Terrestrial Mammals via Camera Trap” carried out by Prof. Ana Cristina Oliveira (Photo: Rafael Assis).

15. Student Involvement and Exchange

One of BRC's main objectives is to integrate students into research projects. With the expansion of research activities, the number of students involved also increases. By the end of 2021, a total of 99 students were involved in BRC research projects: 37 at the bachelor's level, 20 at the master's level, 25 at the doctoral level, and 17 at the postdoctoral level (Figure 13). These numbers show an increase of almost 20% in the number of students linked to BRC projects compared to the previous year (2020). A substantial increase was observed at all academic levels supported by the BRC-Hydro partnership, from bachelor's, to master's, doctoral and post-doctoral students.

This increase is mainly due to the start of projects approved in the last BRC call (2019), since most began operating in 2021. Therefore, despite many projects already completed, the implementation of more recent projects allowed the maintenance of a high number of students linked to the most different BRC projects.

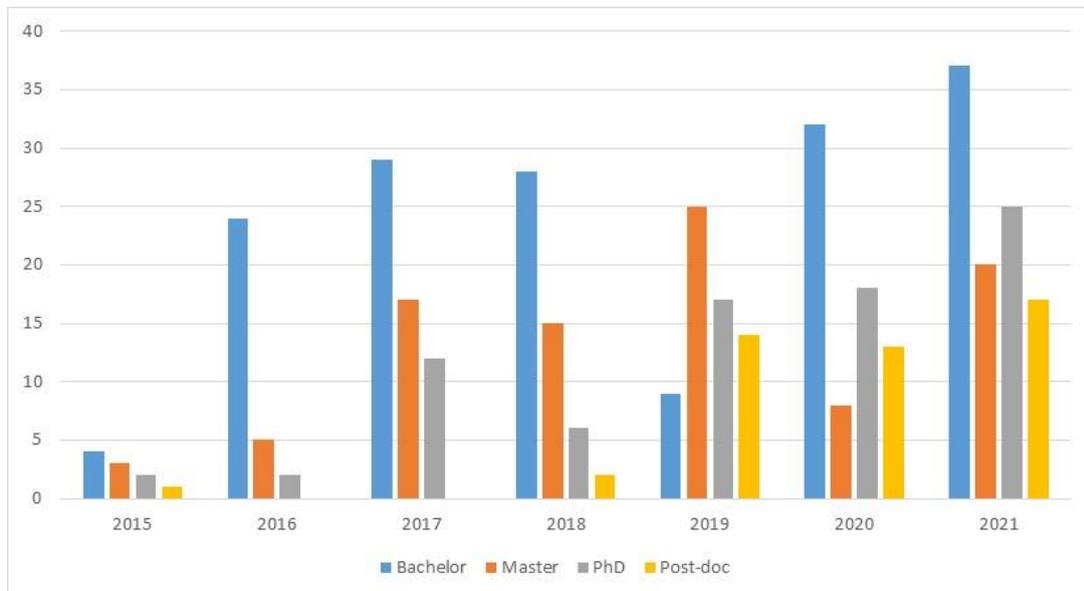


Figure 13: Number of students involved in BRC research projects from 2015 to 2021.

In previous years, some of these students had the opportunity to experience part of their studies abroad, taking part in exchange programs at the institutions participating in the Consortium. For example, some Norwegian students who participated in the tropical forest field course extended their stay in Brazil to develop their master's thesis. In all cases, they recognized that the exchange was a very important experience, both professional and personal, despite the language barrier.

In 2021, as in 2020, the physical exchange of students was however not possible due to travel limitations caused by the pandemic. Even so, the students were able to participate and interact with other students in meetings and virtual forums promoted by researchers from different BRC partner institutions. These events were important to strengthen the relationship between the research groups and open up possibilities for the future in a scenario where the exchange of students is again possible.

16. Biodiversity Indicators Initiative

Since February 2019, the initiative to develop a document on diversity indicators in the area influenced by Hydro's mining in Paragominas has been a major challenge for the BRC team of researchers and collaborators. It emerged primarily with the aim of putting into practice results and lessons learned from BRC projects to promote the development of more sustainable practices by the mining company, in addition to better monitoring the evolution of the initiatives of the environmental restoration program.

The effort to advance this initiative began with the seminars on Biodiversity Indicators held at UFRA – Paragominas in February 2019, and included researchers, employees and students from BRC, in addition to the team from Hydro do Brazil and Norway. At this event, a seminal document began to be prepared, based on the discussions promoted during the seminar. Since then, a group that included BRC project leaders, collaborators and the secretariat have held meetings and discussions in order to produce a more definitive framework document on biodiversity indicators. The idea was the creation of a document containing indicators of restoration of the most diverse elements of biodiversity, from water and soil quality, vegetation and fauna. It would, therefore, make use of the expertise of the different collaborating researchers of BRC as well as the lessons learned from their developed research projects in the Hydro area.

Led by Prof. Ana Cristina Oliveira, and with the participation of Prof. Norberto Noronha (UFRA), Prof. Gracialda Ferreira (UFRA), Prof. Marcos Piedade (UFRA) and Prof. Marlúcia Martins (MPEG), and collaboration with Rafael Leandro de Assis (BRC), Prof. Leandro Juen (UFPA), Prof. Thaísa Michelan (UFPA), Victor Barbosa (Hydro) and Patrick Branding (Hydro), a final version of the document was delivered and presented to the BRC Scientific Committee at the September 2021 meeting. The document, entitled *“Technical Report on Biodiversity Indicators for Programs for the Recovery of Degraded Areas in the Amazon (PRAD), with an emphasis on bauxite mining”*, is available in the BRC repository (Dropbox files).

For next steps, Hydro will have internal discussions on the report, and subsequently meetings between Hydro and the indicator group will likely be scheduled in early 2022 to discuss how the proposed structure in the report can be applied and used in its PRAD program.

17. Roundtable between Researchers from BRC and Hydro

In October 2021, a new initiative was proposed and led by Hydro. It consists of establishing a dialogue, in a roundtable format, between Hydro employees and BRC project leaders. The main objective is to discuss the challenge that has been to incorporate the results of BRC projects into the mining company's restoration/sustainable practices. Hydro aspires to be a leader in conducting ecologically sustainable mining operations, and the use of results from BRC projects is central to that achievement. Thus, the debates resulting from the roundtable should encourage discussions and allow the results of the projects to be converted into the best operational practices of the mining company.

The first project considered for this initiative was BRC 03/14: *“Biodiversity, proliferation of plant species and restoration of areas degraded by bauxite mining in the southeast region of Pará”*, led by researchers Marcos André Piedade Gama and Gracialda Ferreira, both from UFRA. One of

the reasons for choosing this project is that it is one of those that have already been concluded, in addition to having numerous scientific publications, plus book chapters, and dozens of master's and PhD theses.

The roundtable was attended by approximately ten people, including researchers and Hydro employees, and also had the participation of the BRC secretariat. It was divided into two sessions, on different days, and lasted approximately six hours in total (both days combined). Thanks to the debate on the results presented, Hydro is already proposing to change some of its operating activities in the mining area. Their aim is to optimize its practices for the recovery of degraded areas, in addition to other operations that may be more sustainable or less impactful to the environment. For next year, other researchers would be invited to attend the roundtable and discuss other BRC projects.

18. The BRC Book

A proposal for the creation of a book between the BRC-Hydro's partnership was initiated in March 2020. This material should be mainly focused on Amazon rainforest biodiversity, and how human disturbance influence the biodiversity. Specifically, the book will be targeting the Paragominas case, where the forest was degraded by mining, among many human activities. In this case though, the mining company (Hydro) has initiated a forest restoration program. To support the program, Hydro proposed the creation of the BRC, which has been conducting biodiversity surveys and research at the mining area. The book thus aims to summarize this partnership, as well the achievements that the projects have made so far.

For authorship, several BRC collaborating researchers from different areas of expertise were invited. In addition to researchers, the book should also have the participation of the BRC secretariat, Hydro employees, and other members of the consortium.

The year 2021 has also been a very challenging year for further progress on the BRC book initiative. This mainly due to the excess of demands referring to Hydro's administrative tasks to deal with the BRC projects, which ended up preventing a significant advance in the preparation of the book. Although some chapters have already been partially completed, the contract between Hydro and the invited publisher has made little progress. Hopefully, any administrative hurdle related to this initiative will be solved in the near future, so that we can finally complete the consortium's so much expected book.

19. BRC's Website and Social Media

The official website of BRC was constantly updated during the year 2021. News, reports, events and other relevant information about the activities of the consortium were regularly posted on the website (www.brcbn.com). This is an important tool for students and the general public to get to know the BRC better and be informed about upcoming events, such as courses, seminars, opportunities, research teams and others.

In addition to the website, BRC has been very active on social media. The consortium recently created its Twitter page (@BRCAmazon), which already has more than 40 followers. On this channel, most of the information is posted in English, in an attempt to reach a more international audience. BRC also has a Facebook account, created in 2018 (@BRCAmazon). This

account has been constantly updated with posts related to news from the BRC (e.g. publications, achievements, etc.), opportunities, events and news about forest science, environment, etc. These media channels are extremely important to spread the science that is done by the BRC teams, and to attract more people who might be interested in collaborating or integrating some of the research projects – mainly students. Posts on the BRC Facebook page are written mainly in Portuguese, with a focus on the Brazilian audience. Today, our Facebook page has more than 500 followers (a hundred more than the previous year), and reached more than 5600 people along the year of 2021 (Figure 14).

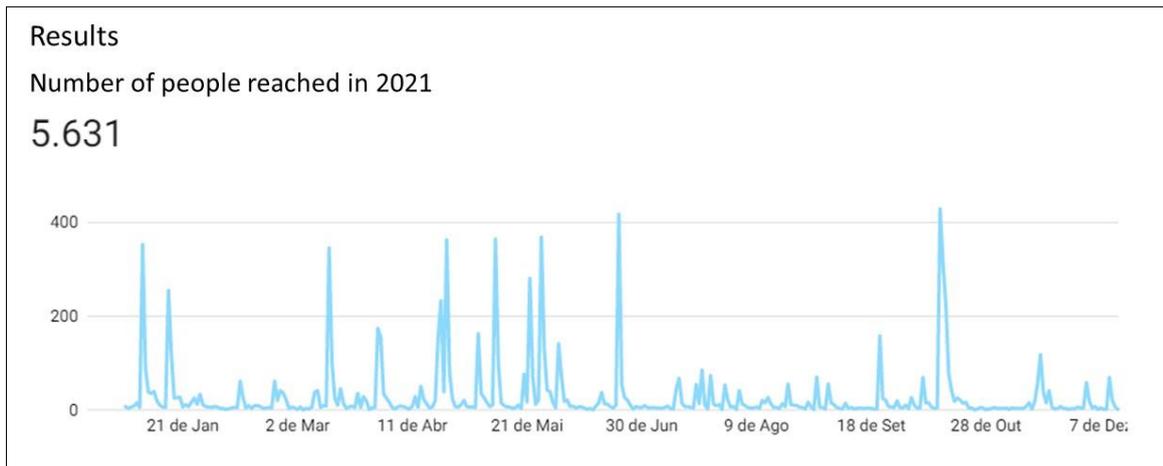


Figure 14. Number of people monthly reached by BRC’s Facebook page along the year of 2021 (Source: Facebook Insights)

20. Participation in Events

Researchers and colleagues associated to BRC integrated several events throughout 2021 and had the opportunity to disseminate results of BRC projects, in addition to joining round tables and debates on themes related to the environment and mining. One of them, promoted by SOBRADE (Brazilian Society for the Recovery of Degraded Areas), addressed the theme “Environmental Management in Mining”. Held in the form of online seminars (Webinar), it took place between November 29th and 30th 2021, and counted with approximately 50 participants from different regions in Brazil and abroad.

Among those that presented a talk/seminar, Evaldo Francisco (Hydro) gave a seminar on “Planning and Environmental Management in Mining: from Theory to Practice”, together with representatives of other mining companies, such as Vale and Anglo. Members of BRC, such as Ana Cristina Oliveira (UFPA) and Marlúcia Martins (MPEG) presented a seminar on “Recovery Programs and Environmental Indicators”. Professors Gracialda Ferreira (UFRA) and Marcos Piedade Gama (UFRA) also presented at the event, with the seminars “Degradation Processes and Degradation Practices: Advances and Challenges”. Students who developed their postgraduation thesis linked to BRC projects gave talks: Denis Conrado, Walmer Bruno Martins and Rodrigo Barbosa, all from UFRA. They presented the seminar “Criteria for Monitoring and Evaluation of Performance in the Revegetation of Degraded Areas”, together with professor Gracialda Ferreira. The program of the event is shown in Figure 15.

Another event with wide participation of BRC members was the Annual Meeting arranged by

the Latin American Society of Odonatas. This event aimed to bring together scholars that study the insect group Odonata (dragonflies), to present works and initiate debates on studies carried out with this insect group. In total, eight students/researchers associated with the LABECO (Ecology Laboratory) group at UFPA, led mainly by Prof. Leandro Juen participated in the event. Several projects supported by the BRC were presented, mainly linked to the project BRC 10/15 – “Aquatic biota monitoring of streams in mining areas of Paragominas SA, Pará, Brazil”.

Seminário

Gestão Ambiental na Mineração

Uma avaliação 360 graus

De onde viemos, onde estamos e para onde devemos ir?

Programação

Dia 29/11	Dia 30/11
<p>08h Sessão de abertura</p> <p>08h15-10h Mesa redonda A Gestão Ambiental na busca da Sustentabilidade na Mineração Luis Henrique Sanchez (USP), Juarês José Aumond (FURB) e Ramis Tetu (DesenvolVerde)</p> <p>10h - 10h15 Intervalo</p> <p>10h15 - 11h Cidades Mineradoras e o Desenvolvimento Sustentável Maria Amélia da Silva Enriquez (Diretora de Acordos Internacionais- UFPA)</p> <p>11h - 11h45 Licenciamento e Governança na Atividade Minerária no Brasil Júlio H. de Azevedo (IBAMA) e Carlos Romero Martins-Diretoria de Licenciamento Ambiental (IBAMA)</p> <p>11h45 - 12:15h Os Impactos Ambientais da Mineração através da Avaliação do Ciclo de Vida- Márcio De Lazzari-PhD, M.Eng, MSc, BSc, MT</p> <p>12h15 - 14h Intervalo</p> <p>14h - 16h Planejamento e Gestão Ambiental na Mineração: da Teoria à Prática Equipes técnicas da VALE, HYDRO e ANGLIO</p> <p>16h - 16h15 Intervalo</p> <p>16h15 - 17h A revegetação como protagonista do Sequestro de Carbono e Biorremediação. Um passo além, na Recuperação Ambiental Carlos Roberto Sanquetta (UFPR)</p> <p>17h - 17h 30 O Setor Minerário Contribuindo com a Década da Restauração da ONU Ricardo Ribeiro Rodrigues (ESALQ-USP)</p> <p>17h30 - 18h15 Operação Correta da Barragem de Rejeitos Arthur Pinto Chaves (Escola Politécnica da USP - Depto de Eng. de Minas e de Petróleo)</p>	<p>08h - 09h30 Programas de Recuperação e Indicadores Ambientais Ana Cristina Mendes de Oliveira (UFPA) e MarluCIA Martins (Museu Paraense Emílio Goeldi)</p> <p>09h30 - 10h Conceitos de Engenharia Natural Aplicáveis Fabricio Sutilli (UFSM) e Paola Sangalli (Federação Européia de Engenharia Natural - EFIB)</p> <p>10h - 10h15 Intervalo</p> <p>10h15 - 11h45 Aplicabilidade da Restauração Ecológica na Recuperação de Áreas Degradadas pela Mineração Sebastião Venancio Martins (UFV), Denis Conrado (Museu Paraense Emílio Goeldi), Walmer Bruno Martins (UFRA) e Rodrigo Barbosa (Mineração Taboca)</p> <p>11h45 - 13h45 Intervalo</p> <p>13h45 - 15h Processos de Degradação e Práticas de Recuperação: Avanços e Desafios GraciAlda Costa Ferreira (UFRA), Marcos Gama (UFRA), Walmer Bruno Martins (UFRA)</p> <p>15h - 16h20 Critérios de Monitoramento e Avaliação de Desempenho na Revegetação de Áreas Degradadas GraciAlda Costa Ferreira (UFRA), Denis Conrado (UFRA), Walmer Bruno Martins (UFRA) e Rodrigo Barbosa (Mineração Taboca)</p> <p>16h20 - 16h35 Intervalo</p> <p>16h35 - 17h35 Potencial de Uso de Resíduos Urbanos para a Revegetação de Áreas Mineradas Katia Goldschmidt Beltrame (MK2R) e Rodrigo Studart Corrêa (UNB)</p> <p>17h35 - 18h20 Geotecnologias e sua Aplicação como Ferramenta em Projetos Ambientais Denis Conrado (Museu Paraense Emílio Goeldi)</p>

29 e 30 de Novembro de 2021 (on-line)

Ciclo de Palestras on-line, com evento presencial em Belo Horizonte-MG nos dias 9 e 10 de Dezembro (Programação em breve no site)

Realização:

 Sociedade Brasileira de Recuperação de Áreas Degradadas



Patrocínio:

Apoio:



Figure 15. Complete program (in Portuguese) of the event organized by SOBRADE with the theme “Environmental Management in Mining”, with wide participation of members of BRC and Hydro.

21. BRC in the Alliance for Restoration of the Amazon

The Alliance for Amazon Restoration, created in 2017, is a multi-institutional initiative focused on

facilitating and promote forest restoration in the Brazilian Amazon. The mission of this union of partners is to promote integration between different actions and cooperation between multiple agents engaged in the theme, being them NGOs, companies, academia, government and civil society. The Alliance acts as a catalyst and amplifier of the restoration agenda in the Amazon, seeking to: reconcile interests and integrate actions in favor of expanding the scale and efficiency of forest restoration; generate, systematize and disseminate knowledge and information on forest restoration, tropical forestry and agroforestry systems; support fundraising by members to enable forest restoration actions and projects; boost the economy of forest restoration, stimulating all links in the production chain, generating business, employment and income opportunities; contribute to the formulation and implementation of public policies and positions that favor forest restoration; among others.

BRC is represented in the Alliance by some researchers, such as professors Ana Cristina Oliveira (UFPA), Alberto Akama (MPEG) and Marlúcia Martins (MPEG). Since May 2021, BRC secretariat has also become a more active part of the Alliance, joining meetings, debates, seminars and assemblies. BRC has played an important role in the elaboration of the Alliance's strategic planning, mission propositions, in addition to the choice of members belonging to the Alliance's board and executive secretariat.

The role of BRC in the Alliance is of great importance for expanding the network of the consortium partners, in addition to sharing experiences and also improving the learning. In addition, it is important to combine efforts to better act in the recovery and restoration of Amazonian environments. BRC is expected to continue working in collaboration with Alliance members for years to come.

22. Lessons Learned

The year 2021 was another year of progress for BRC, despite all the restrictions and challenges caused by the pandemic. The consortium advanced in its most important goals, mainly with regard to developing research activities, improving the university-company partnership, increasing its relevance through its publications and social networks, and finally in the integration of students and professors/researchers from different institutions. Below are some of the achievements and challenges faced:

- *The difficulties caused by the pandemic substantially impacted the progress of research activities, especially for field work. However, it did not necessarily affected the interaction between partners, as well as professional training programs and publication of scientific results. This in fact reinforces that BRC is a very well-established consortium, and with an adequate structure for its long existence;*
- *More frequent meetings (e.g. monthly) were highly important to update consortium members, to share information about challenges and experiences, and find solutions to problems. These meetings also proved to be extremely important to keep pertinent themes of the consortium on the radar and streamline processes relevant to the progress of research projects;*
- *Despite frequent meetings and the excellent dialogue channel between the parties, the high demand for administrative procedures managed by Hydro, including signing contracts, budget review and general document processes, has often resulted in delays and compromising a*

satisfactory advancement of BRC projects and initiatives. A further internal assessment of how to optimize these procedures is recommended, on both the BRC and Hydro side;

- BRC had another very successful year in the production of publications in relevant scientific journals. These numbers, which are expected to continue to be high for the coming years, demonstrate that the consortium is fulfilling its objective of increasing its relevance in advancing the field of forest restoration and biodiversity in areas affected by mining;*
- The establishment of roundtables between BRC researchers and Hydro employees appears to address a long-standing challenge: to facilitate the incorporation of BRC research findings into the mining company's restoration practices. Despite being a newly established initiative, the experience gained showed that it can be an excellent tool for the company to propose more ecologically sustainable operations;*
- Online platforms for meetings, classes and lectures worked very well during the pandemic period and can be used as communication channels between BRC members. This platform will certainly continue to be used very frequently in the future, and it will be of great importance to maintain a dialogue between the parties, especially involving the two countries.*

Oslo, January 11st 2021.

Rafael Assis and Fridtjof Mehlum

Annex 1: BRC – Overview of all research projects (Last Update: 03.01.2022).

Project title	Institution / Coordinator	Contract signed	Did it start already?
BRC 01/14: Arbuscular mycorrhizal fungi in natural areas and areas in restoration after bauxite mining in Pará	UFPA Altamira/Magali Goncalves Garcia UNIFESSPA/Ulisses Albino	YES	YES
BRC 02/14: Measuring the emissions of trace gases in chrono-sequence of reforestation in areas influenced by bauxite mining in Paragominas	UFPA Braganca/Hudson Cleber Pereira da Silva	YES	YES
BRC 03/14: Biodiversity, proliferation of plant species and restoration of degraded areas from bauxite mining	UFRA/Marcos André Piedade Gama	YES	YES *
BRC 04/15: Entomology Survey and Bioindicators for Biodiversity Monitoring	MPEG/Rogério Rosas	YES	YES
BRC 05/15: Camera trap survey of ground-living mammals in the Hydro bauxite mine area	UiO/Øystein Wiig, UFPA/Ana Cristina de Oliveira	YES	YES
BRC 06/15: Evaluation of chemical compounds of different forest species stored, susceptible to contamination in the soil.	UFRA/Gracialda Costa Ferreira	YES	YES *
BRC 07/15: Impact study of a biodiversity recovery program in a bauxite mining area on populations of insect vectors	UFPA/Ivoneide Maria da Silva	YES	YES *
BRC 08/15: Bird diversity in three areas in different states of conservation in the Eastern Amazon.	UFPA/Marcos Persio Dantas Santos	YES	YES *
BRC 09/15: Wood-decay fungi in Paragominas and Trombetas: baseline information, monitoring priorities, and how to achieve the “no net loss” target?	UiO/Hugo de Boer	YES	YES
BRC 10/15:Aquatic biota monitoring of streams in mining areas of Paragominas SA, Pará, Brazil	UFPA - MPEG/Akama, Juen and Montag	YES	YES *
BRC 11/15: Diversity of the herbivorous insects in four areas of the Hydro mining company	UFPA/José Antonio M. Fernandes	YES	YES
BRC 12/16: How ecological interactions are influenced by mining activities and efforts for environmental restoration after exploration	MPEG/Marluca Martins	YES	YES
BRC 13/16 Tracking jaguars in the Hydro bauxite mine area in Paragominas, Brazil	UiO/UFPA Øystein Wiig /Leonardo Sena	YES	YES
BRC 14/17 Monitoring Amphibians and Squamata Reptiles in Reforestation Areas in the Hydro Bauxite Mine Area in Paragominas, Brazil.	UFPA/Maria Cristina dos Santos Costa	YES	YES
BRC 15/17 Rehabilitation techniques in bauxite mining areas - A topsoil study	UFRA/Gracialda Ferreira	NO	NO
BRC 16/19 - Measuring biodiversity dynamics using environmental DNA and metabarcoding	UiO - Jonathan Stuart Ready	YES	YES
BRC 17/19 - Metabarcoding and metagenomics for high throughput inventory and monitoring of terrestrial arthropod biodiversity	UFPA/Gustavo Ruiz UiO/ Vladimir Gusarov	YES	YES
BRC 18/19 – Metagenomic and metabarcoding as a tool for developing One Health In Hydro Area	UFPA/Leonardo Sena	YES	YES

BRC 19/19 - Use of native species from different trophic levels and occurring in bauxite mining area to evaluate the toxicity of residues	UFPA/Lilian Lund Amado	YES	YES
BRC 20/19 - Aquatic biota monitoring and assessment upstream and downstream of bauxite pipeline Norsk Hydro Paragominas - Barcarena	UFPA/Luciano Montag	YES	YES
BRC 21/19 - Bird telemetry monitoring to evaluate loss of habitat in mining area	UFPA/Marcos Persio Dantas Santos	Yes	NO
BRC 22/19 - Effect of large herbivorous mammals on forest regeneration in post-mined areas	UFPA/Maria Aparecida Lopes	YES	YES
BRC 23/19 - The use of physical, chemical and biological tools to evaluate the water resources under the influence of the Norsk Hydro	UFPA/Rossineide Martins da Rocha	YES	NO
BRC 24/19 - Coexistence plan for human and carnivores	UFPA/Leonardo dos Santos Sena	YES	YES
BRC 25/19 - Assessing the integrity of aquatic ecosystems by implementing a next generation DNA sequencing-based method for biomonitoring	UFPA/Raphael Ligeiro	YES	YES
BRC 26/19 - Effects of soil use on diversity and ecophysiology on the riparian vegetation, aquatic macrophytes and plankton in streams and lagoons	UFPA/Thaísa Sala Michelan	YES	YES

* Project concluded

Annex 2: BRC – List of all published articles from the BRC series number (Last update: 03.01.2022).

BRC number	Title	Journal/book	Authors	Affiliation	Vol.	Issue n.	Pages	Year
BRC0001	<i>Imantodes lentiferus</i> - Geographic Distribution	Herpetological Review	Axandre C. Ascenso; Alexandre F.R. Missassi	MPEG	46	3	386	2015
BRC0002	Deposição de serapilheira e nutrientes em áreas de mineração submetidas a métodos de restauração florestal em Paragominas, Pará	FLORESTA	Martins, Walmer B.R.; Ferreira, Gracialda C., Souza, Fernanda P.; Dionísio, Luiz Fernandes S.; Oliveira, Francisco de Assis	UFRA	48	1	37-48	2018
BRC0003	Forest Restoration Evaluation Through Indicators in Areas of Bauxite Mining	Floresta e Ambiente	Ribeiro, Sabrina S.; Oliveira, Francisco de Assis; Ferreira, Gracialda C.; Santos, Daniel E.; Cruz, Denis C.	UFRA	26	3	online	2019
BRC0004	Litterfall, litter stock and water holding capacity in post-mining forest restoration ecosystems, Eastern Amazon	Revista Brasileira de Ciências Agrárias	Martins, Walmer B.R.; Vale, Raquel L.; Ferreira, Gracialda C.; Andrade, Vanda M.S.; Dionísio, Luiz Fernandes S.; Rodrigues, Richard P.; Oliveira, Francisco de Assis; Souza, Giuliana M.P.	UFRA	13	3	online	2018
BRC0005	After 10 years the myth of <i>Crotalaria</i> spp. and dragonflies remains alive	Biota Netropica	Joás Brito; Nayara Louback-Franco; Cristian Mendoza; Flávia Nonato; Leandro Juen; Thaisa Michelan	UFPA				2020
BRC0006	Environmental factors influencing the abundance of four species of threatened mammals in degraded habitats in the eastern Brazilian Amazon	PlosOne	Juliana Teixeira-Santos, Ana Carolina da Cunha Ribeiro, Øystein Wiig, Nelson Silva Pinto, Lorrane Gabrielle Cantanhede, Leonardo Sena, Ana Cristina Mendes Oliveira	UFPA, UiO	online	online	online	2020
BRC0007	Environmental factors affect macrophyte diversity on Amazonian aquatic ecosystems inserted in an anthropogenic landscape	Ecological Indicators	Ana Luísa B. Fares, Lenize Batista Calvão, Naiara Raiol Torres, Ely Simone C.Gurgel, Thaísa Sala Michelan	UFPA	113	online	online	2020
BRC0008	New records of the invasive macrophyte, <i>Urochloa arrecta</i> extend its range to eastern Brazilian Amazon altered freshwater ecosystems.	Acta Amazonica	Ana Luisa Biondi Fares; Flávia Alessandra da Silva Nonato; Thaísa Sala Michelan	UFPA				2020
BRC0009	<i>Voragocoris weirauchae</i> sp. n. (Heteroptera: Schizopteridae: Schizopterinae), a further minute litter bug species from Brazil	Zootaxa	Flavio Roberto de Albuquerque Almeida, Fernando da Silva Carvalho-Filho, Jose Antonio Marin Fernandes	UFPA, MPEG	4729	1	138-144	2020
BRC0010	Tree communities in 3-yr-old post-mining sites under different forest	Forests	Denis Conrado da Cruz, José María Rey Benaya, Gracialda Costa Ferreira, Sabrina Santos Ribeiro	UFRA	527	11		2020

	restoration techniques in the Brazilian Amazon								
BRC0011	The Habitat Integrity Index and aquatic insect communities in tropical streams: A meta-analysis	Ecological Indicators	Leandro Schlemmer Brasil, Edgar Luiz de Lima, Zander Augusto Spigoloni, Danielle Regina Gomes Ribeiro-Brasil, Leandro Juen	UFPA	116	<i>online</i>			2020
BRC0012	Morphological and allometric variation due to percentage of cover in <i>Eichhornia azurea</i> (Swart) Kunth (Pontederiaceae)	Brazilian Journal of Botany	Cintia Oliveira Carvalho, Kelsey Archer Barnhill, Alexandre Cordeiro Ascenso, Barbara Dunck, Grazielle Sales Teodoro, Thaisa Sala Michelan	UFPA, MPEG, NMBU		<i>online</i>			2020
BRC0013	Survival, growth and regeneration of forest species in mining areas in the Eastern Amazonia	Scientia Plena	W. B. R. Martins; W. dos S. Barros; L. F. S. Dionisio; T. G. Bezerra; M. L. dos Santos; Gracialda. C. Ferreira; V. M. Barbosa; F. de A. Oliveira	UFRA	6	<i>online</i>			2020
BRC0014	Caracterização biométrica de sementes de <i>Solanum paniculatum</i> L. e desempenho germinativo após superação de dormência	Revista Colloquium Agrariae	Elson Junior Souza da Silva, Lorene Bianca Araújo Tadaiesky, Jéssy Anni Vilhena Senado, Dênora Gomes de Araujo	UFRA	6	4	29-37		2020
BRC0015	Assessing sodium limitation as a resource for ground-dwelling ants (Hymenoptera:Formicidae) in an area of the Amazonian Terra Firme Forest	Bol. Mus. Para. Emilio Goeldi. Cienc. Nat.	Cristian Camilo Mendoza-Penagos, Knut Olav Vadla Hessen , Rony Peterson Santos Almeida	UFPA, MPEG, UiO	15	1	135-143		2020
BRC0018	Contamination of stream fish by plastic waste in the Brazilian Amazon	Environmental Pollution	Danielle Regina Gomes Ribeiro-Brasil, Naiara Raiol Torres, Ana Beatriz Picanço, David Silva Sousa, Vanessa Serrao Ribeiro, Leandro Schlemmer Brasil, Luciano Fogaça de Assis Montag	UFPA	266	<i>online</i>			2020
BRC0019	Diversity of macrophytes in the Amazon deforestation arc: information on their distribution, life-forms and habits (<i>accepted</i>).	Rodriguesia	Thaisa Michelan et al.	UFPA					2020
BRC0020	Metals in different environmental compartments and biomarkers of oxidative stress in the fish <i>Bryconops caudomaculatus</i> (Osteichthyes: Characiformes) from a bauxite mining area in the Brazilian Eastern Amazon (<i>in prep.</i>)	Chemosphere	Lilian Amado et al.	UFPA					2020
BRC0021	Growth and Quality of <i>Inga heterophylla</i> Wild Seedlings According	Journal of Agricultural Science	Elson J. S. da Silva, Jéssy A. V. Senado, Ádson E. da Silva, Marcos A. P. Gama, Selma T. Ohashi, Giuliana M. P. de	UFRA	11	5	479-484		2019

	to the Slow Release Fertilizer		Souza, Gracialda C. Ferreira, Norberto C. Noronha, Gilson S. B. de Matos, Dênora G. de Araujo					
BRC0022	Collecting arboreal arthropods: a technique for sampling plant-inhabiting arthropod communities in a tropical forest understory (<i>accepted</i>)	Entomologia Experimentalis et Applicata	Viana-Junior AB, Quijano-Cuervo L, Ferreira JC, Reis RRN, Santos IA, Martins MB	MPEG				2020
BRC0023	Effects of landscape and local habitat on Odonata larvae (Insecta) communities in eastern Amazon streams (<i>in submission</i>)	Marine and Freshwater Research	Rodrigo Arison Barbosa Ribeiro ^{1,2*} , Leandro Juen ^{1,2} & Leandro Schlemmer Brasil ^{1,2}	UFPA				2020
BRC0024	Mudanças no uso da terra alteram os riachos e afetam os grupos funcionais alimentares de insetos aquáticos na amazônia (<i>in submission</i>)	Ecological Indicator	Myllena Suzi Lima Silva, Viviane Caetano Firmino, Carina Kaory Sasahara de Paiva, Leandro Juen, Leandro Schlemmer Brasil	UFPA				2020
BRC0025	Seed viability changes during fruit ripening of <i>Tapirira guianensis</i> : Implications for collection (<i>accepted</i>)	Research, Society and Development	Denmora et al.	UFRA				2020
BRC0026	Morphological and phylogenetic factors structure the distribution of damselfly and dragonfly species (Odonata) along an environmental gradient in Amazonian streams	Ecological Indicators	Rafael Costa Bastosa, LeandroSchlemmer Brasil, José Max Barbosa Oliveira-Juniora, Fernando Geraldo Carvalho, Gareth D. Lennox, Jos Barlow, Leandro Juen	UFPA	122			2021
BRC0027	The role of macrophyte architecture in driving periphytic algal communities in a lowland river in the Brazilian Amazon	Brazilian Journal of Botany	Híngara Leão; Louise Cathrine Rolstad Esdar; Bárbara Dunck	UFPA, MPEG, NMBU	<i>online</i>			2021
BRC0028	The anthropic gradient determines the taxonomic diversity of aquatic insects 1 in Amazonian streams.	Hydrobiologia	Carina Kaory Sasahara de Paiva, Ana Paula Justino Faria, Lenize Batista Calvão, Leandro Juen	UFPA	<i>online</i>			2021
BRC0029	Bark of <i>Astronium lecontei</i> Ducke Trees from the Amazon: Chemical and Structural Characterization	European Journal of Wood and Wood Products	Graciene S. Mota; Elesandra S. Araujo; Mario Lourenco; Juliana Livian L. de Abreu; Claudia L.S. de O. Mori; Cassiana A. Ferreira; Marcela G. Silva; Fabio Akira Mori; Gracialda Ferreira	UFRA	<i>online</i>	5		2021
BRC0030	Estoque de serapilheira e nutrientes: indicadores da restauração de ecossistemas degradados pela mineração de bauxita	Empreendedorismo e Inovação na Engenharia Florestal 3 (<i>Book</i>)	Julia Isabella de Matos Rodrigues, Walmer Bruno Rocha Martins, Victor Pereira de Oliveira, Gracialda Costa Ferreira, Victor Moreira Barbosa, Francisco de Assis Oliveira.	UFRA				2021
BRC0031	Desenvolvimento e qualidade de	Scientia Plena	V. P. Oliveira; R. S. Mendes; W. B. R. Martins; E. A.	UFRA				2021

	mudas de <i>Parkia gigantocarpa</i> Ducke (Fabaceae) em função de fertilizante de liberação controlada		Santos; D. G. Araújo; M. A. P. Gama					
BRC0032	Natural Regeneration for restoration of degraded areas after bauxite mining: a case study in the Eastern Amazon	Ecological Engineering	Alberto B. Brasil Neto; Gustavo Schwartz; Norberto C. Noronha; Marcos A. P. Gama; Gracialda Costa Ferreira	UFRA	171			2021
BRC0033	Taxonomic diversity and functional diversity of bird communities in mining areas undergoing passive and active restoration in eastern Amazon (<i>in submission</i>)		Persio et al.	UFPA				2021
BRC0034	Response of aquatic insects to an environmental gradient in Amazonian streams (<i>accepted</i>)	Environmental Monitoring and Assessment	Ana Paula Justino Faria; Carina Kaory Sasahara de Paiva; Lenize Batista Calvão; Gabriel Martins da Cruz; Leandro Juen	UFPA				2021
BRC0035	Evaluation of the phytosociological structure of a forest fragment in the Municipality of Paragominas-PA, Brazil	Research, Society and Development	Ana Cláudia Vale do Nascimento; Paulo Luiz Contente de Barros; Gracialda Costa Ferreira; Jéssica Costa dos Santos; Francimary da Silva Carneiro	UFRA	10	9		2021

