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Redes de Colaboração na Reserva Extrativista de Canavieiras, Brasil

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RESUMO

A degradação dos ambientes marinhos e costeiros, e a consequente perda da biodiversidade e dos serviços ecossistêmicos associados tem um forte impacto nas comunidades humanas costeiras. Tanto o livre acesso como as estratégias de gestão centralizadas têm provado ser ineficazes no manejo dos recursos comuns da pesca. Neste contexto, a implementação do modelo de cogestão envolve complexidades sociais e ecológicas, a fim de promover a governança por meio da participação de múltiplos atores como o governo, organizações da sociedade civil comunidades locais e usuários dos recursos. Os atores envolvidos e a forma como estes interagem determinará certas estruturas da rede que podem facilitar ou dificultar distintos processos. Com foco na Reserva Extrativista de Canavieiras (CER) este artigo usa a análise da rede social para avaliar a presença de capital social e lideranças que promovam a ação coletiva para contornar problemas relacionados à 1) conservação da biodiversidade, 2) governança e 3) socioeconomia. As redes encontradas apresentam estruturas de ligação e de ponte, denotando a presença de capital social e lideranças. Baixos valores de densidade caracterizam as redes como esparsas, refletindo a presença de diferentes pontos de vista e a falta de confiança entre as instituições, o que pode comprometer a ação coletiva. O Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio - órgão ambiental do governo responsável pela cogestão) foi a instituição mais procurada para solucionar quase todos os problemas. Esta instituição central tem a capacidade de atuar como coordenador, fomentando a ação coletiva. Comunidades tradicionais, lideradas pela Associação Mãe dos Extrativistas (AMEX), fornecem o capital social necessário para a ação coletiva. AMEX e ICMBio se reconhecem como instituições importantes para a ação coletiva e parecem trabalhar juntos pelo sucesso da cogestão. Os resultados indicam que os governos locais não estão engajados na ação coletiva e podem acabar atuando como um obstáculo. Várias instituições parecem compartilhar a posição de ponte nas redes, revelando a descentralização desse papel. Os níveis de fragmentação da rede foram baixos, indicando que atores heterogêneos estão unidos, fomentando o capital social. A dependência do ICMBio para a ação coletiva pode ter implicações para a resiliência do sistema, uma vez que esta instituição pode atrasar e dificultar o processo de ação coletiva como resultado da sua estrutura complexa e burocrática.

Palavras-chave: cogestão, governança, pesca em pequena escala, análise da rede social, capital social, liderança, áreas marinhas protegidas, recursos de uso comum.

ABSTRACT

The degradation of marine and coastal environments, and the consequent loss of biodiversity and associated ecosystem services, has a strong impact on coastal human communities. Both free access and centralized management strategies have proved to be ineffective in managing common-pool fishery resources. In this context, the implementation of the co-management model involves social and ecological complexities in order to promote governance through the participation of multiple actors like governments, social civil organizations, local communities and resource users. The actors involved and the way in which they interact will determine certain network structures that can facilitate or hinder different processes. With focus on the Canavieiras Extractive Reserve (CER) this article uses social network analysis to assess network structures that denote social capital and leadership that promote collective action to solve problems related to 1) biodiversity conservation, 2) governance and 3) socioeconomic issues. The networks found have bonding and bridge structures, denoting the presence of social capital and leadership. Low density values characterize networks as sparse, reflecting the presence of different points of view and the lack of trust between institutions, which can compromise collective action. The Chico Mendes Institute for Biodiversity Conservation (ICMBio - governance environmental agency responsible for the co-management) was the most sought after institution to solve almost all problems. This central institution has the capacity to act as coordinator, promoting collective action. Traditional communities, led by Mother Association of Extractivists (AMEX), provide the necessary social capital for collective action. AMEX and ICMBio are recognized as important institutions for collective action and seem to work together for the success of co-management. The results indicate that local governments are not engaged in collective action and may end up acting as an obstacle. Several institutions seem to share the bridge position in the networks, revealing the decentralization of this role. Unlike expected the levels of network fragmentation were low, indicating that heterogeneous actors are united, and fostering social capital. ICMBio's reliance on collective action may have implications for the system's resilience, as this institution may delay and hinder the collective action process as a result of its complex and bureaucratic structure.

Keywords: co-management, governance, small-scale fishing, social network analysis, social capital, leadership, marine protected area, common-pool resource.

INTRODUÇÃO GERAL

Globalmente, os ambientes marinhos e costeiros têm estado sob forte pressão de diferentes atividades antrópicas, causando a degradação destes ambientes e a perda da biodiversidade e dos serviços ecossistêmicos a eles associados (FAO, 2016; WORM et al., 2006). Particularmente as áreas costeiras têm experimentando umas das mais altas taxas de alterações ambientais durante o último tempo (HALPERN et al., 2008). Nestas áreas vive e se concentra cerca do 40% da população do mundo (BARRAGÁN; DE ANDRÉS, 2015) que depende da obtenção de distintos bens e serviços fornecidos pelos ecossistemas marinhos (SELIG et al., 2019).

A redução dos recursos pesqueiros impacta diretamente os meios de subsistência das comunidades humanas costeiras (a partir daqui apenas “comunidades”) e a pesca de pequena escala, os quais dependem da qualidade dos ecossistemas marinhos e costeiros para a manutenção da sua forma de vida (ANDREW et al., 2007; FERROL-SCHULTE et al., 2015). Durante muito tempo a importância da pesca de pequena escala foi subestimada devido a falta de estimativas globais confiáveis sobre as suas contribuições nas economias nacionais e regionais, e sobre o papel que ela tem na segurança alimentar e desenvolvimento das comunidades costeiras (BENÉ, 2006). Hoje, já se sabe que a pesca de pequena escala emprega a grande maioria dos pescadores do mundo (90%), é responsável por quase metade da captura mundial destinada ao consumo humano, e dá suporte à subsistência de muitas comunidades costeiras ao redor do mundo (BERKES, 2021; FAO, 2016). Particularmente na América Latina estima-se que cerca de 2 milhões de pessoas estão direta ou indiretamente ligadas à pesca de pequena escala, contribuindo para a segurança alimentar e a amenização da pobreza na região (HANAZAKI et al., 2013).

Neste cenário, as Áreas Marinhas Protegidas (AMPs) surgiram para minimizar o impacto das atividades humanas nos meios marinho e costeiro, e servir como instrumento de gestão da pesca (BERKES, 2021). No entanto, para garantir a sustentabilidade da pesca de pequena escala, é necessário que se considere a complexidade destes ambientes e de suas dimensões sociais e ecológicas (BERKES, 2021; GUTIERREZ; HILBORN; DEFEO, 2011). A implementação e consolidação bem-sucedida das AMPs requer o forte apoio e a colaboração das comunidades pesqueiras locais. Frente a isto, várias AMPs adotaram estratégias de cogestão, contando com o envolvimento direto das comunidades costeiras envolvidas no processo de gestão como uma forma de aumentar a conformidade e a eficácia da gestão pesqueira (ALEXANDER; ARMITAGE; CHARLES, 2015; ARAUJO et al., 2017; GUTIERREZ; HILBORN; DEFEO, 2011; NOBRE et al., 2017; OSTROM, 1990)

A estratégia de cogestão baseada na comunidade é uma alternativa para lidar com a “tragédia dos comuns” de Hardin (HARDIN, 1968), que postulava a privatização do recurso ou o controle do governo como as únicas opções para lidar com a governança e alcançar a sustentabilidade dos recursos naturais (OSTROM, 1990; OSTROM et al., 1999). Os “recursos naturais comuns”, “recursos comuns” o simplesmente “os comuns”, são recursos naturais que

apresentam dificuldades logísticas para implementação de restrições de acesso, e cujo uso por uma pessoa diminui seu valor para uso por outras pessoas (OSTROM et al., 1999). A “tragédia dos comuns”, isto é a degradação dos recursos comuns, parece ser inevitável em sistemas de grandes dimensões, com recursos altamente valiosos sob regime de livre acesso, e frente a diversos usuários que não se comunicam e portanto fracassam em estabelecer regras de manejo (OSTROM, 2009). Porém neste cenário, a privatização do recurso, assim como, o controle do governo não sempre resultaram ser estratégias eficazes para lidar com a degradação dos recursos (OSTROM; NAGENDRA, 2006). Resolver os problemas de uso dos recursos comuns envolve dois elementos distintos: 1) a restrição do acesso, ou seja, excluir potenciais usuários que não sejam membros do grupo definido, e 2) a capacidade do grupo definido de fazer regras mutuamente aceitáveis para regular o uso dos recursos entre os membros (BERKES, 2021; OSTROM et al., 1999).

A pesca de pequena escala é um recurso de uso comum com um histórico de distintas estratégias de manejo. Por muito tempo em todo o mundo as políticas governamentais foram dirigidas e favoreceram a pesca de larga escala marginalizando a pesca de pequena escala (BERKES, 2021). O livre acesso aos recursos pesqueiros teve consequências socioeconômicas e ecológicas desastrosas em todo o mundo (BERKES, 2021; CINTI et al., 2010). Por outro lado, as estratégias de gestão de cima para baixo centralizadas no Estado também provaram ser pouco adequadas para garantir a conservação dos recursos naturais e a sustentabilidade da pesca de pequena escala (BERKES, 2021; CINTI et al., 2010). Porém, a cogestão baseada na comunidade, onde pescadores, gestores e outros atores trabalham juntos para regular o uso dos recursos pesqueiros, foi adotada em diversas partes do mundo, e já conta com ampla evidencia de sucesso (FAO, 2016; GUTIERREZ; HILBORN; DEFEO, 2011). Esta estratégia geralmente vem acompanhada da concessão dos direitos de posse dos recursos pesqueiros (TURFs do inglês *tenure rights to fishery resources*) para as comunidades (BERKES, 2021; CRONA; GELCICH; BODIN, 2017), com a ideia de que a restituição e fortalecimento dos direitos dos pescadores de pequena escala incentive o uso sustentável dos recursos (CRONA; GELCICH; BODIN, 2017).

Resumindo, a cogestão baseada na comunidade fundamenta-se na noção de que é necessário descentralizar o poder de decisão para conseguir a gestão dos recursos comuns (CARLSSON; BERKES, 2005). Neste sentido, cobra relevância a incorporação nos processos decisórios de diferentes atores que representam as diferentes áreas da sociedade (exe.: agências governamentais, instituições de pesquisa, organizações não governamentais, sector privado, comunidades locais e usuários dos recursos, entre outros), que colaboram entre si e compartilham responsabilidades (CARLSSON; BERKES, 2005; SANDSTRÖM; CARLSSON, 2008). No entanto, essa abordagem colaborativa reúne outras implicações. Normalmente, a ideia de como usar e gerenciar recursos de uso comum não é única, uma vez que os atores envolvidos têm interesses diferentes e muitas vezes conflitantes sobre como conduzir essa tarefa (BODIN, 2017). Assim, entre outros aspectos, os sistemas de governança devem tentar integrar os diferentes interesses envolvidos (BODIN, 2017). Nesse sentido, a cogestão pode ser entendida como um

sistema de governança em rede, no qual diferentes atores interagem e modelam as “regras do jogo” (CARLSSON; BERKES, 2005; SANDSTRÖM; CARLSSON, 2008).

Mesmo que as estratégias de cogestão tenham acumulado uma ampla gama de evidências de sucesso (BERKES, 2021; GUTIERREZ; HILBORN; DEFEO, 2011), também existem indícios de que a governança colaborativa nem sempre leva a melhores resultados (BODIN, 2017; BODIN; SANDSTRÖM; CRONA, 2017; ROBINS, 2011). Nesse sentido, parece que as iniciativas de cogestão são bem mais complexas do que “apenas um conjunto de atores engajados em colaboração” (BODIN, 2017; SANDSTRÖM; CARLSSON, 2008). Prestar atenção à estrutura da rede colaborativa, ou seja, quem são os atores e como eles se engajam (ou não) é uma forma de elucidar por que alguns tipos de arranjos de cogestão parecem ter mais sucesso do que outros (BODIN, 2017; BODIN; CRONA, 2009; SANDSTRÖM; CARLSSON, 2008; SANDSTRÖM; ROVA, 2010).

Emerson, Nabatchi e Balogh (2012) consideram o “engajamento” dos atores como um processo dinâmico, e uma das engrenagens fundamentais da governança colaborativa no seu “*Integrative Framework for Collaborative Governance*”. Nesse trabalho, os autores consideram o “engajamento” quando diferentes atores, com distintos conhecimentos e objetivos em comum, trabalham através dos limites institucionais ou jurisdicionais para colaborar na resolução de problemas e conflitos. O “engajamento” é importante porque, através da repetição de interações entre os atores, gera-se confiança, a qual na sua vez fomenta o entendimento mútuo, a legitimidade interna, e o compromisso compartilhado, gerando então a “motivação compartilhada” (ou capital social), considerada também uma engrenagem fundamental da governança colaborativa (EMERSON; NABATCHI; BALOGH, 2012).

O *framework* da análise da rede social (ARS) (DEGENNE; FORSE, 1999), demonstrou ser uma abordagem útil para compreender as relações entre os diferentes atores engajados na cogestão e os processos sociais subjacentes, como colaboração, coordenação, ação coletiva, troca de informações, aprendizado, construção de confiança e capital social (BODIN; CRONA; ERNSTSON, 2006). A ARS considera que os atores, organizações ou instituições (representados na rede por nós) junto com as relações entre eles (representadas por arestas ou conexões) formam uma rede (GRANOVETTER, 1985). Esta análise permite modelar e quantificar as interações entre os diferentes atores e a estrutura da rede resultante (DEGENNE; FORSE, 1999), e tem ganhado atenção nos últimos anos, com ampla aderência entre os pesquisadores (ALEXANDRE; ARMITAGE, 2015; MARIN, 2012).

Na ARS, a maneira em que os atores se engajam na colaboração, determinará estruturas da rede que podem facilitar ou dificultar diferentes processos e seus resultados (BODIN; CRONA; ERNSTSON, 2006; SANDSTRÖM; CARLSSON, 2008; SANDSTRÖM; ROVA, 2010). Portanto, certos tipos de redes de cogestão poderiam ser mais eficazes que outras devido a certas características de sua estrutura. Não obstante, não existe uma estrutura da rede que seja “ideal”, em vez disso, existe uma compensação (*tradeoff*) entre certas características da rede que

irão promover ou não diferentes processos da governança (ALEXANDER; ARMITAGE; CHARLES, 2015; BODIN; CRONA, 2009). Por exemplo, uma rede caracterizada por uma alta densidade de relações entre os atores pode contribuir para o fortalecimento da confiança, aumentando assim a possibilidade de controle social (GRANOVETTER, 1985). Porém, densidades muito altas de relações na rede podem levar a uma homogeneização de experiências e conhecimentos, reduzindo a diversidade das percepções dos atores sobre os comportamentos do ecossistema, que por sua vez pode diminuir sua capacidade coletiva de responder às mudanças (BODIN; CRONA; ERNSTSON, 2006). Desse modo, diferentes estruturas da rede irão se ajustar a diferentes propósitos (ALEXANDER; ARMITAGE; CHARLES, 2015; BODIN, 2017; BODIN; CRONA, 2009; ROBINS; BATES; PATTISON, 2011).

Geralmente os atores se envolvem ou iniciam processos de governança colaborativa com o propósito de impulsionar ações ou resolver problemas que não ser pela colaboração entre as partes, não poderiam ser alcançadas por qualquer uma delas individualmente (EMERSON; NABATCHI; BALOGH, 2012). Uma vez estabelecidas as relações de colaboração, o resultado do engajamento será uma ação coletiva para resolver algum problema complexo (EMERSON; NABATCHI; BALOGH, 2012). A seleção dos diferentes atores com os quais colaborar (exe.: agências governamentais, instituições de pesquisa, organizações não governamentais, usuários do recurso, etc.) dependerá da interação entre dois fatores: 1) dos atributos do potencial parceiro (condutores endógenos), e 2) da natureza do problema particular a ser resolvido (condutores exógenos) (BERARDO; SCHOLZ, 2010; BODIN, 2020; NOHRSTEDT; BODIN, 2020). Em relação ao primeiro fator, um ator avalia os demais com quem colaborar com base na confiança, no compartilhamento de semelhanças, de interesses e de pontos de vista (homofilia); nos atributos que tornam o outro ator atrativo (capacidade de fornecer recursos humanos, financeiros ou técnicos, etc.); e no engajamento que o outro ator tenha no processo de gestão, possivelmente torando-o um ator mais “popular” (BODIN, 2020; NOHRSTEDT; BODIN, 2020). De toda forma, a relevância dos atributos dos potenciais parceiros dependerá da capacidade de contribuir na resolução de um problema específico de ação coletiva (NOHRSTEDT; BODIN, 2020). Portanto, a estrutura da rede resultante será formada pela interação dos fatores endógenos e exógenos que determinaram a formação das relações (NOHRSTEDT; BODIN, 2020).

Os atributos de capital social e liderança são tidos como condições fundamentais para a ação coletiva (BODIN, 2020; BODIN; CRONA, 2008; CRONA; GELCICH; BODIN, 2017; GUTIERREZ; HILBORN; DEFEO, 2011; MARIN, 2012). O capital social refere-se ao conjunto de relações, ou seja, as redes sociais e valores compartilhados ou normas criadas e usadas por indivíduos que facilitam a ação coletiva (MARIN, 2015; PRETTY, 2003). A presença de atores que exerçam liderança facilita a ação coletiva mediante coordenação (GUTIERREZ; HILBORN; DEFEO, 2011). Ambos os conceitos são promotores ou iniciadores do engajamento dos atores, mas também são processos subjacentes deste engajamento, que se retroalimentam (EMERSON; NABATCHI; BALOGH, 2012).

Inicialmente tinha-se a noção de que o capital social por si só era responsável pela ação coletiva, porém trabalhos demonstraram que a liderança também exerce um papel importante, já que lideranças ativas e engajadas podem acionar o capital social para a ação coletiva (BODIN; CRONA, 2008; GUTIERREZ; HILBORN; DEFEO, 2011). No entanto, o recente trabalho de Crona, Gelcich e Bodin (2017) ressalta que a presença de capital social pode amortecer a falta de lideranças.

O capital social tende a formar estruturas de ligação na rede (*bonding network structures*) representadas por altas frequências de interação e reciprocidade. Esse tipo de estrutura denota a presença de laços fortes e coesão social, que promovem o desenvolvimento da confiança, normas e pontos de vista comuns (OSTROM, 1990). Esses aspectos são importantes por reduzirem o risco e o custo de colaborar com outros atores, o que permite alcançar níveis maiores de ação coletiva (OSTROM, 1990; PRETTY, 2003). No entanto, altos níveis de laços de ligação (*bonding ties*) podem promover a homofilia (atores com características semelhantes tendem a se relacionar entre si) e fomentar a ideia equivocada de "nós-e-eles", que pode resultar na formação de diferentes coalizões (BODIN, 2017).

As estruturas de ponte (*bridging network structures*) indicam a presença de lideranças, e se caracterizam por laços fracos e atores centralizados que podem conectar outros atores ou subgrupos da rede que, de outra forma, não estariam conectados (BODIN; CRONA, 2009). Este tipo de estrutura pode facilitar a colaboração e fomentar a ação coletiva se os atores centrais atuarem como coordenadores, iniciando a ação coletiva e coordenando os recursos (BODIN et al., 2020; BODIN; CRONA, 2009).

Lembrando que a compensação (*tradeoff*) existente entre as estruturas de ligação e de ponte determina a estrutura resultante da rede de colaboração, alguns trabalhos ressaltam que uma rede com ambos elementos estruturais parece ser mais capaz de promover a resiliência nas comunidades e aumentar sua capacidade de adaptação para mudanças ambientais (BODIN; CRONA; ERNSTSON, 2006). Consequentemente, conhecer a rede colaborativa resultante é importante para entender as implicações que as diferentes características estruturais da rede têm na ação coletiva. O resultado da ação coletiva (se os problemas são ou não resolvidos) irão afetar diretamente a adaptação da governança colaborativa.

As Reservas Extrativistas representam uma categoria de áreas protegidas que, no Brasil, se caracterizam por incluir as comunidades e populações tradicionais em seu modelo de governança (PRADO; CASTRO; SEIXAS, 2019; SANTOS; SCHIAVETTI, 2013). O principal objetivo dessas áreas é proteger os meios de vida e a cultura das populações extrativistas tradicionais, garantindo o uso sustentável dos recursos naturais, conciliando a conservação com uma economia local sustentável (CARDOZO et al., 2012).

A Reserva Extrativista de Canavieiras se localiza no nordeste do Brasil, estado da Bahia, e sua área compreende predominantemente o ecossistema marinho, sendo o restante formado por

ecossistemas costeiros e/ou aquáticos, como manguezais e estuários. As comunidades tradicionais da área dependem dos recursos naturais para sua sobrevivência e obtenção de renda, e as principais atividades que realizam são a pesca artesanal, a coleta de moluscos e a agricultura familiar (CARDOZO et al., 2012; DUMITH, 2018). Esta reserva surgiu como resultado da institucionalização governamental e adoção nos ambientes marinho e costeiro do modelo de Reserva Extrativista, gerado através da luta dos seringueiros pelos direitos da terra na floresta amazônica (PRADO; CASTRO; SEIXAS, 2019; PROST, 2018). Com essa institucionalização, a gestão das Reservas Extrativistas permanece sob responsabilidade do Instituto Chico Mendes para Conservação da Biodiversidade (ICMBio), um órgão ambiental nacional (PROST, 2018).

Esta estratégia de conservação adota o modelo de cogestão de base comunitária e a concessão dos direitos de posse dos recursos (TURFs) às comunidades tradicionais (SANTOS; SCHIAVETTI, 2013). Assim, a cogestão da Reserva Extrativista se caracteriza por um processo participativo em que diferentes atores envolvidos - instituições governamentais, sociedade civil e comunidades extrativistas tradicionais - formam um Conselho Deliberativo, um espaço regulado para discussão onde os envolvidos compartilham o poder e a tomada de decisões (SANTOS; SCHIAVETTI, 2013). Neste Conselho as comunidades extrativistas tradicionais detêm a maioria dos votos como forma de salvaguardar os seus direitos.

Com a incorporação de múltiplos atores na cogestão, surgiram diversos desafios. Particularmente na Reserva Extrativista de Canavieiras um destes desafios é a presença de distintos interesses, por vezes conflitantes, entre os diferentes setores envolvidos (DUMITH, 2018; PROST, 2018). Apesar disso, esta unidade de conservação se caracteriza pelo bom desempenho do processo decisório, destacando-se pelo papel central do órgão gestor e a coesão e capacidade de organização das comunidades tradicionais, as quais apresentam altos níveis de participação e engajamento (CARDOZO et al., 2012, 2019). Simultaneamente, destaca-se o fraco envolvimento das instituições governamentais locais e da sociedade civil (CARDOZO et al., 2012, 2019; DIAS et al., 2018; SANTOS; SCHIAVETTI, 2014).

No entanto, para a Reserva Extrativista de Canavieiras, pouco se sabe sobre o engajamento dos atores envolvidos e o potencial de passar da discussão para a ação coletiva quando o objetivo é resolver problemas concretos relacionados à gestão. O presente estudo visa aprofundar o conhecimento avaliando, mediante a análise da rede social, as características estruturais das redes de colaboração para a ação coletiva na Reserva Extrativista de Canavieiras, nordeste do Brasil, e as implicações que as características das redes podem ter para a resiliência e adaptação do processo de cogestão. Particularmente, o estudo analisa a presença de capital social e de lideranças que promovam ações de colaboração para contornar problemas relacionados à 1) conservação da biodiversidade, 2) governança e 3) socioeconomia.

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CHAPTER 1

COLLABORATIVE NETWORKS, SOCIAL CAPITAL AND LEADERSHIP FOR COLLECTIVE ACTION IN A BRAZILIAN COASTAL EXTRACTIVE RESERVE

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ABSTRACT

The implementation of the co-management approach in coastal and marine environments is a strategy to address the social and ecological complexities of these areas and foster the governance through the participation of multiple actors like governments, social civil organizations, local communities and resource users. The way in which actors engage in collaboration will determine certain network structures that can facilitate or hinder different process. With focus on the Canavieiras Extractive Reserve (CER) this article uses social network analysis to assess network structures that denotes social capital and leadership that promote collective action to solve problems related to 1) biodiversity conservation, 2) governance and 3) socioeconomics issues. The networks found shows both bonding and bridging structures. The low density values characterize the networks as sparse reflecting the presence of different views and the lack of trust and common understanding among institutions which can compromise collective action. The Chico Mendes Institute for Biodiversity Conservation (ICMBio - governance environmental agency responsible for the co-management) was the more sought institution for solving almost all the problems. This central institution has the capacity to acting as a coordinator, and fosters collective action. Traditional communities with the Mother Association of Extractivists (AMEX) as a leader provide the social capital for collective action. Also AMEX and ICMBio work together watching for the success of the co-management. Local governments are not engaged in collective action and they end up acting like an obstacle for collective action. Several institutions seem to share the bridging position in the networks revealing the decentralization of this role. Unlike expected, even if the networks were sparse, the levels of network fragmentation were low indicating that heterogeneous actors are knitting together to foster the social capital. The dependency of the ICMBio for collective action can have implications for the resilience of the system due to its complex and bureaucratic structure, which can delay and hinder the collective action process.

Keywords: co-management, governance, small-scale fisheries, social network analysis, marine protected area, common-pool resource.

RESUMO

A implementação do modelo de cogestão em ambientes costeiros e marinhos é uma estratégia para abordar as complexidades sociais e ecológicas dessas áreas e promover a governança por meio da participação de múltiplos atores como o governo, organizações da sociedade civil, comunidades locais e usuários dos recursos. A forma como os atores interagem determinará certas estruturas da rede que podem facilitar ou dificultar distintos processos. Com foco na Reserva Extrativista de Canavieiras (CER) este artigo usa a análise da rede social para avaliar a presença de capital social e lideranças que promovam a ação coletiva para contornar problemas relacionados à 1) conservação da biodiversidade, 2) governança e 3) socioeconomia. As redes encontradas mostram estruturas de ligação e ponte. Baixos valores de densidade caracterizam as redes como esparsas refletindo a presença de diferentes visões e a falta de confiança e entendimento comum entre as instituições o que pode comprometer a ação coletiva. O Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio - órgão ambiental do governo responsável pela cogestão) foi a instituição mais procurada para solucionar quase todos os problemas. Esta instituição central tem a capacidade de atuar como coordenador fomentando a ação coletiva. Comunidades tradicionais junto com a Associação Mãe dos Extrativistas (AMEX) como líder fornecem o capital social necessário para a ação coletiva. AMEX e ICMBio se reconhecem como instituições importantes para a ação coletiva e trabalham juntos pelo sucesso da cogestão. Os governos locais não estão engajados na ação coletiva e acabam atuando como um obstáculo. Várias instituições parecem compartilhar a posição de ponte nas redes, revelando a descentralização desse papel. Ao contrário do que era esperado, mesmo que as redes fossem esparsas, os níveis de fragmentação da rede foram baixos, indicando que atores heterogêneos estão unidos fomentando o capital social. A dependência do ICMBio para a ação coletiva pode ter implicações para a resiliência do sistema, uma vez que como resultado da sua estrutura complexa e burocrática esta instituição pode atrasar e dificultar o processo de ação coletiva.

Palavras-chave: cogestão, governança, pesca em pequena escala, análise da rede social, áreas marinhas protegidas, recursos de uso comum.

1. INTRODUCTION

Around marine and coastal environment in the world, Marine Protected Areas (MPAs) have been implemented to reduce the impact of human activities and to avoid the decline of common-pool fisheries resources (BERKES, 2021). Due to the interactions involved with small-scale fisheries and the social and natural complexities, most MPAs adopt co-management strategies to foster the governance through the participation of multiple actors like governmental organizations, local communities, resource users, and other stakeholders (ALEXANDER; ARMITAGE; CHARLES, 2015; BERKES, 2021; GUTIERREZ; HILBRON; DEFEO, 2011). Then, co-management can be understood as a network governance system in which different actors share the power and decision-making, and interact shaping the “rules of the game” (CARLSSON; BERKES, 2005; SANDSTRÖM; CARLSSON, 2008).

Even if co-management strategies have been growing around the globe accumulating a wide evidence of success (BERKES, 2021; GUTIERREZ; HILBRON; DEFEO, 2011) this is not the rule and there is also evidence that collaboration not always leads to increased performance and better outcomes (BODIN, 2017; BODIN; SANDSTRÖM; CRONA, 2017; ROBINS; BATES; PATTISON, 2011). One way to elucidate why some kinds of co-management arrangements seem to be more successful than others is paying attention to the network structure formed by actors engaged in collaboration, that is, who the actors are and how they interact (or not) (BODIN, 2017; BODIN; CRONA, 2009; SANDSTRÖM; CARLSSON, 2008; SANDSTRÖM; ROVA, 2010).

The social network approach (SNA) gained attention in the last years having a broad adherence among researches (ALEXANDER; ANDRACHUK; ARMITAGE, 2016; COHEN; EVANS; MILLS, 2012; CRONA; GELCICH; BODIN, 2017; KLUGER et al., 2020; MARÍN et al., 2012; RAMIREZ-SANCHEZ; PINKERTON, 2009) The idea behind is that, how actors engage in collaboration will determine certain network structures that can facilitate or hinder different process (e.g. coordination, collective action, exchange of information, learning) and its outcomes (BODIN; CRONA; ERNSTSON, 2006; SANDSTRÖM; CARLSSON, 2008; SANDSTRÖM; ROVA, 2010). Then, the success or failure of co-management network performance will be associated with how this network is structured. Furthermore, there is no an “ideal” network structure, instead, there is a tradeoff between certain characteristics of the network that supports different governance process (ALEXANDER; ARMITAGE; CHARLES, 2015; BODIN; CRONA, 2009). Then, different network structures will adjust to different purposes (ALEXANDER; ARMITAGE; CHARLES, 2015; BODIN, 2017; BODIN; CRONA, 2009; ROBINS; BATES; PATTINSON, 2011). The SNA enables the elaboration of models and the quantification of the interactions among the different actors and the resultant network structure (DEGENNE; FORSE, 1999).

Governmental collaborative networks often are implemented to address collective action problems (BODIN, 2017). With whom actors choose to collaborate will depend on the interaction

between the attributes of the potential partner (endogenous drivers) and the particular collective action problem (exogenous drivers) (BERARDO; SCHOLZ, 2010; BODIN, 2017; BODIN et al., 2020; NOHRSTEDT; BODIN, 2020). Regarding to the former, an actor can select with whom collaborate based on trust, the sharing of similarities like common vision and interest (homophily), the others actor's attractive attributes – like the capacity to provide human, financial or technical resources – and the engagement in the management process that can make an actor more “popular” (BODIN et al., 2020; NOHRSTEDT; BODIN, 2020). In any case, the relevance of the potential partners' attributes will depend on the capacity to fit in a specific collective action problem (NOHRSTEDT; BODIN, 2020). Then the resultant network structure will be shaped by the interaction of the endogenous and exogenous factors that determined tie formation (NOHRSTEDT; BODIN, 2020).

Leadership and social capital have been proposed as necessary preconditions for collective action (BODIN, 2020; BODIN; CRONA, 2008; CRONA; GELCICH; BODIN, 2017; GUTIERREZ; HILBORN; DEFEO, 2011; MARIN, 2012). Social capital refers to the rules and social networks that facilitate collective action (MARIN, 2015; PRETTY, 2003), and leadership to the presence of actors that facilitates collective action through coordination (GUTIERREZ; HILBORN; DEFEO, 2011). Initially, there was the notion that social capital alone was responsible for collective action, but studies have shown that leadership also plays an important role, since active and engaged leaders can activate social capital for collective action (BODIN; CRONA, 2008; GUTIERREZ; HILBORN; DEFEO, 2011). The recent work of Crona, Gelcich and Bodin (2017), highlights that the presence of social capital can buffer the lack of leadership.

Social capital tends to develop bonding network structures that characterize for strong ties represented by high frequency of interaction, reciprocity and social proximity. This structure denotes the presence of social cohesion that promotes the development of trust, share views, perceptions and norms (OSTROM, 1990). This is important because it reduces the risk and cost of collaboration with others and then, increased levels of collective action could be achieved (OSTROM, 1990). However, high levels of bonding ties can promote homophily – when actors with similar characteristics tend to relate among them- and foster the wrong idea of “us-and-them” that might result in the formation of different coalitions (BODIN, 2017).

On the other hand, leadership form bridging structures that characterized for weak ties and centralized actors that can connect either actors or network's sub-groups that would not otherwise be connected (BODIN; CRONA, 2009). This type of structure can foster collective action if central actors act as a coordinator facilitating collaboration, initiating action and coordinating resources (BODIN et al., 2020; BODIN; CRONA, 2009).

Therefore, the subsequent network structure will be a result of the tradeoff existent between both bonding and bridging structures. It was stressed that a network that has structural elements of both bonding and bridging social capital looks more capable of building network resilience and increase the capacity to adapt to environmental changes (BODIN; CRONA; ERNSTSON,

2006). Then, knowing the resultant collaborative network is important to highlight the implications for collective action.

This study analyzes the collaborative networks' structures to achieve collective action among the institutions involved in the co-management of the Canavieiras Extractive Reserve (hereafter CER) in Brazil, and the implications that these network' structures can have for the resilience.

The Extractive Reserves (ERs) are a particular category of protected areas in Brazil that includes traditional people in its governance model (PRADO; CASTRO; SEIXAS, 2019; SANTOS; SCHIAVETTI, 2013). ERs aims to protect the livelihoods and culture of the traditional extractive populations, and ensure the sustainable use of natural resources, reconciling conservation with a sustainable local economy (CARDOZO et al., 2012).

Particularly the CER comprises marine coastal and aquatic ecosystems, such as mangroves and estuaries. This reserve emerged as a result of the government institutionalization and adoption, in marine and coastal environments, of the Extractive Reserve model generated as part of the rubber tappers' land struggle in the Amazon forest (PRADO; CASTRO; SEIXAS, 2019; PROST, 2018). Because of this institutionalization, the management of ERs remains under the responsibility of the national environmental agency Chico Mendes Institute for Biodiversity Conservation (hereafter ICMBio) (PROST, 2018).

This conservation strategy adopts a community-based co-management model and the Territorial User Rights for Fisheries (TURFs) to concede the resources use to the traditional communities (SANTOS; SCHIAVETTI, 2013). According with this co-management model, CER characterize by a participative management process in which different actors involved in the Deliberative Council (hereafter DC) - government institutions, civil society and traditional extractive communities - share the power and decision-making (NOBRE; SCHIAVETTI, 2013). In this DC the traditional extractive communities have the majority of the vote as a way of safeguarding their rights.

With the incorporation of multiple actors in the co-management, several challenges arise. Particularly CER previous studies have stressed the presence of different and conflictual interests among the different sectors (DUMITH, 2018; PROST, 2018). Despite that, CER characterizes for the good performance of the decision-making process, stressing the main role of the management agency and the cohesiveness and organization capacity of the traditional communities that shows high levels of participation and engagement (CARDOZO et. al, 2012, 2019). At the same time, it highlights the poor engagement of local governmental institutions and civil society (CARDOZO et. al, 2012, 2019; DIAS et al., 2018; SANTOS; SCHIAVETTI, 2014).

However, little is known about the potential that the CER has to move from discussion to collective action to solve management problems. Therefore, this study uses the SNA with the aim to evaluate the structure of the collaborative networks between the DC institutions to address different problems related to 1) conservation of biodiversity, 2) governance and 3)

socioeconomics issues. Specifically, the study analyzes in the resultant networks the bonding structures (network cohesion, reciprocity and network closure) and bridging structures (central actors) that, respectively, denote the presence of social capital and leadership.

Based on the previous cited studies is expected to find a network structure resulting of the tradeoff among the following: a high centralized management agency, a fragmented network with a densely connected sub-group of traditional community institutions that interact more among them (homophily) and peripheral position of governmental and civil-society institutions. Also, it is expected that the more central institution will be the more suitable to fitting in a specific collective action problem (biodiversity, governance and socioeconomic).

2. METHODS

2.1 Study site

The CER is a community-based co-management protect area that aims to reconcile the use of resources with biodiversity conservation (SANTOS; SCHIAVETTI, 2013, 2014). Situated in Brazil's coastal-marine area, specifically in the south of the state of Bahia, the CER comprises the municipalities of Belmonte, Canavieiras and Una (Figure 1). The CER covers a total area of 100,726.36 ha, of which 83% (83,602.88 ha) correspond to marine area and 17% (17,123,48 ha) to mangroves, rivers and land areas (CARDOZO et al., 2012). The CER was created under Federal decree in the year of 2006 after a bottom-up process that involved the mobilization and organization of the traditional communities (DUMITH, 2018). This area beneficiates approximately 2,300 families of nine different communities: Oiticica, Puxim do Sul, Puxim de Fora, Barra Velha, Canavieiras, Atalaia, Campinhos, Pedras de Una and Belmonte (CARDOZO et al., 2012; DUMITH, 2018). These traditional families depend on natural resources for their income, and the main activities that they perform are traditional fishing, shellfish collection and family farming (CARDOZO et al., 2012; DUMITH, 2018).

2.2 Data collection

A social network survey was designed to address collaborative networks in biodiversity conservation, governance, and socioeconomic issues related to CER. The survey questionnaire (S1 Questionnaire), with a total of 12 questions, was elaborated based on the main topics and problems discussed in the DC meetings. In order to appropriately design the questionnaire, an analysis of the DC meeting minutes respective to the 2010-2019 period was performed.

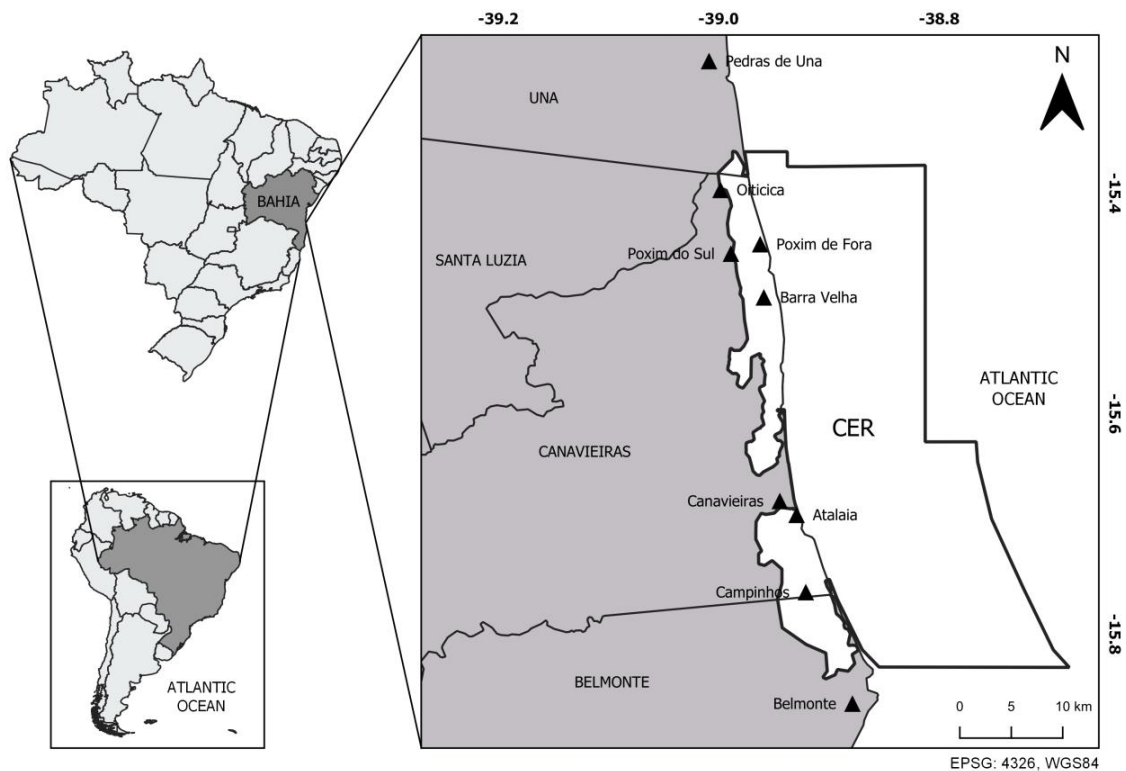


Figure 1: Localization of the study area. CER: Canavieiras Extractive Reserve

Actors representing an institution involved in the CER were interviewed (S2 Table). All of them were participative members in the DC. In cases where the respondent refused to participate in the survey, another member of the same institution, generally the president was interviewed. Was considered that in order to be a suitable actor to answering the questions the respondent should know about the DC's work (ROBINS; BATES; PATTINSON, 2011).

Interviews were arranged by phone call and were conducted, when possible, in the respondent's institution, or in the office of the ICMBio. For respondents who do not live in the CER region, the interview was conducted by online meetings. Before each interview, a written consent was presented to the participants explaining the objectives of the study, the steps, duration (ca. 45 min), how the data would be used and the right to refuse to participate. This was made according to the requirements of the Universidade Estadual de Santa Cruz (UESC) Research Ethics Committee (CEP), which approved this study under the protocol CEP: 3.947.793.

In the survey questionnaire, respondents were asked to characterize the relationships between their institutions with others institutions involved in CER co-management. To achieve that was followed the recognition approach (MARIN; HAMPTON, 2007), then for each question respondents were presented with a list of institutions (S2 Table), and they had to nominate in

order of priority the institutions with which they would count to deal with the different problems or situations presented related to biodiversity conservation, governance, and socioeconomic issues (CRONA; GELCICH; BODIN, 2017; ROBINS; BATES; PATTINSON, 2011).

2.3 Network definition

A network is formed by nodes (actors or institutions) and edges (relations between nodes). In this study, each node in the network represents an institution involved in the CER co-management (S2 Table). To determine the networks boundaries, that is, to define the total set of relevant institutions (nodes) in the network, was followed the nominalist approach (LAUMANN; MARSDEN; PRENSKY, 1989). This approach implies that the researcher pre-defines the nodes and for that the actual list (2020-2022 period) of DC official members was considered.

However, with this criterion in mind researchers perceived that an important institution for the CER performance was being left out of the analysis. This was the case of Mother Association of Extractivists (AMEX, in Portuguese), institution that have signed the TURFs of CER resources and characterizes for gathers all the beneficiary associations having a relevant role in defending the traditional community interests and train community leaders (CARDOZO et al., 2019; DUMITH, 2018). This institution is involved in the CER actions and has a regular participation in the DC meetings despite not being a DC official member (without the right to vote) (CARDOZO et al., 2019). It is interest to note the key role of AMEX institution in organize and articulate the discussions, between the beneficiaries associations, to define priorities and demands to present in the DC meetings (CARDOZO et al., 2019; DUMITH, 2018). In the pilot survey made, this institution was frequently mentioned, so it was included in the networks analysis.

Institutions were categorized as “institution types” according to the sector that represent: the category “beneficiaries” includes the traditional communities that perform artisanal fisheries and others traditional extractive activities; “civil society” includes universities, ONGs, and other types of non-traditional activities like tourism and rural producer sector; and “government” category that include different government level agencies (S2 Table). The universities even being public entities belonging to the government sphere, they were considered as civil society because they have an autonomous organization independent of the government in place.

Network edges represent collaboration relationships between institutions to deal with another in biodiversity conservation, governance, and socioeconomic issues. Edges weights were set based on the priority rank given by the interviewee relative to the total number of institutions. Then, in the present study, all the co-management networks were defined as a multiple (network with more than one edge between two nodes), weighted (network with valuable edges that denote the priority of relation; MARGERUM, 2008), and directed (the direction of network edges was

indicated, in each case, with an arrow coming out from the institution that points the relation; ROBINS; BATES; PATTISON, 2011).

2.4 Data analysis

Of the 33 institutions involved in the CER co-management 30 agreed to participate in the study and answered the questionnaire. That gives a response rate of 90.91 % that allowed us to get reliable estimates of network-level statistics (BERARDO; FISCHER; HAMILTON, 2020). Then, a total of four networks were created: the general network (formed by all the questions) and, based on the different issues approached, the biodiversity, governance and socioeconomic subnetworks (each one formed by 4 questions).

As a first step in the analysis, the average edge weight was calculated. Only edges whose weight was equal to or greater than the average were considered (S3 Figure), since works have shown that the accuracy of the reported information is improved in studies that work with stronger ties (FREEMAN et al., 1977; SANDSTRÖM; ROVA, 2010; WASSERMAN; FAUST, 1994). The visual representation of the graphs was adjusted using the force-directed Fruchterman and Reingold layout algorithm (FRUCHTERMAN; REINGOLD, 1991). The networks arrangements denote that nodes closer to each other share more connections among them. So, nodes that are in the center of the graph share more connections with other nodes than the ones that are peripherals nodes (FRUCHTERMAN; REINGOLD, 1991). Along with the use of visualization, for each network it was estimated a series of statistical metrics that represent certain structural characteristics using the package iGraph (CSARDI; NEPUSZ, 2006) implemented in R version 3.6.0 (R CORE TEAM, 2019).

Bonding social capital: Network connectivity

The level of network cohesiveness was denoted by the density measures. The density of the network reflect how well connected a network is, and was calculated as the number of observed connections divided by the number of possible connections (PRELL, 2011). Also, relational embeddedness was represented with edges reciprocity measure that estimates the proportion of mutual connections at the dyadic level (between two institutions) in a directed graph (ROBINS; BATES; PATTISON, 2011). Structural network closure was denoted with transitivity that measures the probability that two actors tied to a common third will also be tied; the result structure, three actors connected among them, is denominated triad (ROBINS; BATES; PATTISON, 2011).

Bridging social capital: Centrality measures

Two centrality measures that emphasize different aspects of the prominence of nodes were calculated: in-degree, that measures the number of edges directed to a node (WASSERMAN; FAUST, 1994) and will denote the most demanded institution for collective action; and betweenness centrality that measures the extent that a node sits 'between' pairs of

other nodes in the network indicating how important a node is in terms of connecting other nodes (FREEMAN; ROEDER; MULHOLLAND, 1979).

Subgroups detection

Subgroups structure analysis was performed to detect groups of nodes that have a relatively large number of internal edges, and relatively few edges from the group to other parts of the network, and it gives an idea of network fragmentation (community structure, see GIRVAN; NEWMAN, 2004). Subgroups detection was made using the optimal community structure algorithm (BRANDES et al., 2008). This function calculates the optimal subgroups of a graph, by maximizing the modularity measure over all possible partitions. Modularity evaluates the goodness of partitions of a network into clusters or subgroups (GIRVAN; NEWMAN, 2004). The denser was the number of internal edges of the cluster in comparison to these to the outside of the cluster, the better defined the subgroup was. So, large positive values of modularity (considering that the maximal value adopted is 1) indicate good partitions. This subgroup detection algorithm uses link weights but treats the directed edges as undirected.

3. RESULTS

3.1 General characteristics of the collaborative networks

All the networks under study comprised 33 nodes. The statistics networks estimated are shows in Table 1. The general network had 1972 edges distributed in three different topics. The network density was 0.156, which indicates that about 15% of the potential edges are present in the network. The network had 306 pairs of reciprocal edges which gives a reciprocity index of 0.313. The network transitivity was high (0.767) which indicates that about 77% of the adjacent nodes of a node are connected.

Table 1: Summary statistics of the collaborative networks between institutions (beneficiaries, civil society and government bodies) involved in the co-management of the Canavieiras Extractive Reserve, Bahia, Brazil.

Network	Summary statistics			
	Edges	Density	Reciprocity	Transitive triad
General	1972	0.156	0.313	0.767
Biodiversity	632	0,150	0.259	0.639
Governance	662	0,157	0.251	0.629
Socioeconomic	678	0,161	0.251	0.630

The biodiversity, governance and socioeconomic subnetworks presented very similar values of estimated statistics (Table 1). Among them, the biodiversity subnetwork with 632 edges showed the lowest value for density (0.150) and the highest value for reciprocity (0.259) and transitive triad (0.639). The socioeconomic subnetwork with 678 edges had the highest value for density (0.161). Both the governance and socioeconomic subnetworks had the lowest value of reciprocity (0.251).

3.2 Centrality indicators in collaborative networks

The analysis of the centrality indicators in the CER networks denotes the central institutions that are considered relevant for collective action in the co-management process. Figure 2 shows the visualization of the different networks in the CER. Nodes sizes are proportional to in-degree centrality values. All networks show few institutions with high and low centrality values, and many institutions having intermediate centrality values. In the general network (A) the ICMBio was the most prominent institution occupying the central position and having the highest in-degree value. This means that, the ICMBio, was the most nominated institution to count on to deal with the different problems or situations presented in the study. Following an order of priority, the most important institutions are AMEX and the Women Network of Extractive Fishing Communities in the South of Bahia (REDE, in Portuguese) both of them represents the beneficiaries sector (traditional communities that perform artisanal fisheries and others traditional extractive activities), while REDE specifically “gives voice” to the demands and needs of women of this sector, as well as valued the extractive work that they perform (CARMO et al., 2016; DUMITH, 2018).

In contrast, institutions that represent governmental agencies at local scale, and some civil society institutions were the more peripherals with the lowest in-degree values. This was the case for the local government municipalities and city councils of Canavieiras, Belmonte and Una, and for institutions that represent non-traditional activities in the CER, like tourism (see node 26) and rural producer sector (see nodes 28 and 27).

Most of beneficiaries’ institutions had a medium importance, observed by the intermediated in-degree values. Also, nodes that represent the beneficiaries’ institutions displayed closer to each other, indicated that they share more connections among them.

The universities (see node 32) despite having an intermediate in-degree value had a position near to the most priority institutions which indicated that they shared more connections among them.

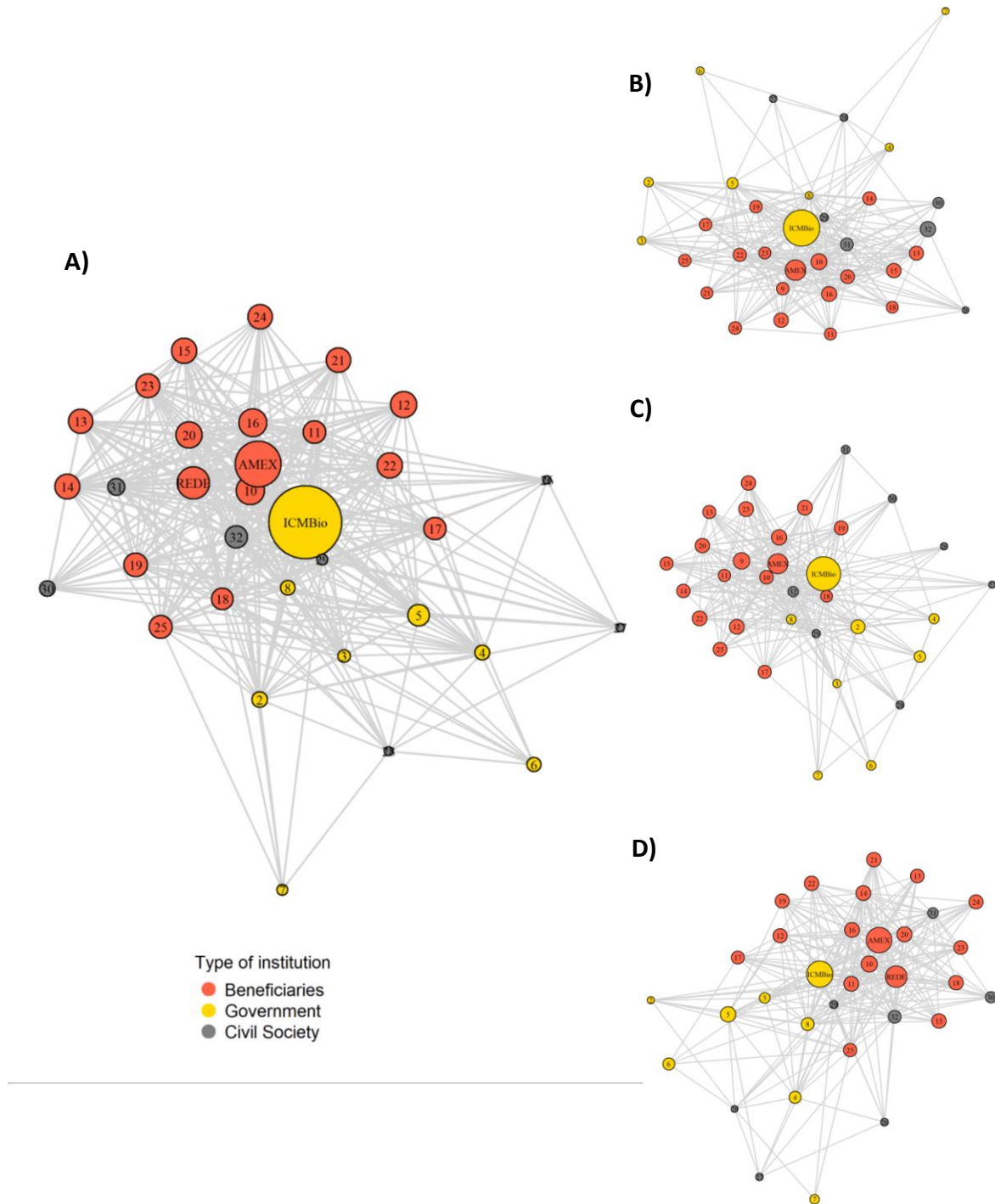


Figure 2: Network visualization for the collaborative management networks in the Canavieiras Extractive Reserve: A) General, B) Biodiversity, C) Governance and D) Socioeconomic networks. Nodes colors represent the different types of institutions (red = beneficiaries, gray = civil society, yellow = government). Node sizes and edges width are proportional to the in-degree centrality values and interaction priority, respectively. The networks were displayed using the force-directed layout algorithm by Fruchterman and Reingold showing nodes that share more connections closer to each other. For number references of nodes see (S2 Table). AMEX: Mother Association of Extractivists, ICMBio: Chico Mendes Institute for Biodiversity Conservation, REDE: Women Network of Extractive Fishing Communities in the South of Bahia.

It is interesting to note that a similar pattern to that observed in the general network also was observed in almost all the subnetworks. Some exceptions and highlights are presented for each subnetwork. The top three priority institutions that follow the ICMBio in the biodiversity subnetwork (B) were the Mother Association of Extractivists (AMEX), the National Commission for the Strengthening of Coastal and Marine Extractive Reserves (CONFREM, in Portuguese) and Universities (UFBA/UESC). For the governance subnetwork (C) were AMEX, REDE and the fishermen's association Colônia Z-20 (union of workers that defend the rights and interest of the artisanal fishing sector and are recognized by the State). In contrast, in the socioeconomic subnetwork (D) the ICMBio and AMEX have very similar values of in-degree centrality being both the most priority institutions, followed by REDE institution.

Some institutions received more importance according to the evaluated subnetwork approach. For example, the universities (UFBA/UESC) have more relevance in the biodiversity subnetwork, being more designated to resolve problems related to monitoring of contamination and pollution of mangroves and waters, and carry out the monitoring of species of socioeconomic interest (S4 Figure). The Navy institution (see node 2) was more nominated in the governance subnetwork than in the others subnetworks, having a relevant role in surveillance issues (S4 Figure). The local government municipalities of Canavieiras, Belmonte and Una cities (see nodes 5, 6 and 8, respectively) received more attention in the socioeconomic subnetwork, being more designated to collaborate with the implementation of tourist activities in the region and the improvement of the quality of life and income of the extractive communities.

Betweenness centrality measure indicates how important an institution is in terms of connecting other institutions in the network. Figure 3 shows networks nodes size proportional to the betweenness centrality values. In the general network the top six ranking institutions with the higher values were: AMEX, CONFREM (categorized as beneficiary institution), ICMBio, UFBA/UESC, REDE (categorized as beneficiary institution), and Municipal Council for the Canavieiras Environment Defense (CONDEMA – civil society institution that propose programs to the protection of the environment and decide on the approval of all projects that involve an environmental decision). These institutions also have an important role in the biodiversity, governance and socioeconomic subnetworks. In addition, the Segment of Artisans, Art makers and Fishing Gear (Artesãos) and Colônia Z-20 also have relative values of betweenness centrality in the governance network, while the same happen for Association of Shellfishes and Fishermen of Pedras de Una (AMEPEDRAS) in the socioeconomic network.

3.3 Subgroups structure

Subgroups detection identified the main groups of institutions that interact more strongly among them than with the rest of the institutions in the network (Figure 3). In all cases, subgroups were not well defined having a great degree of overlap.

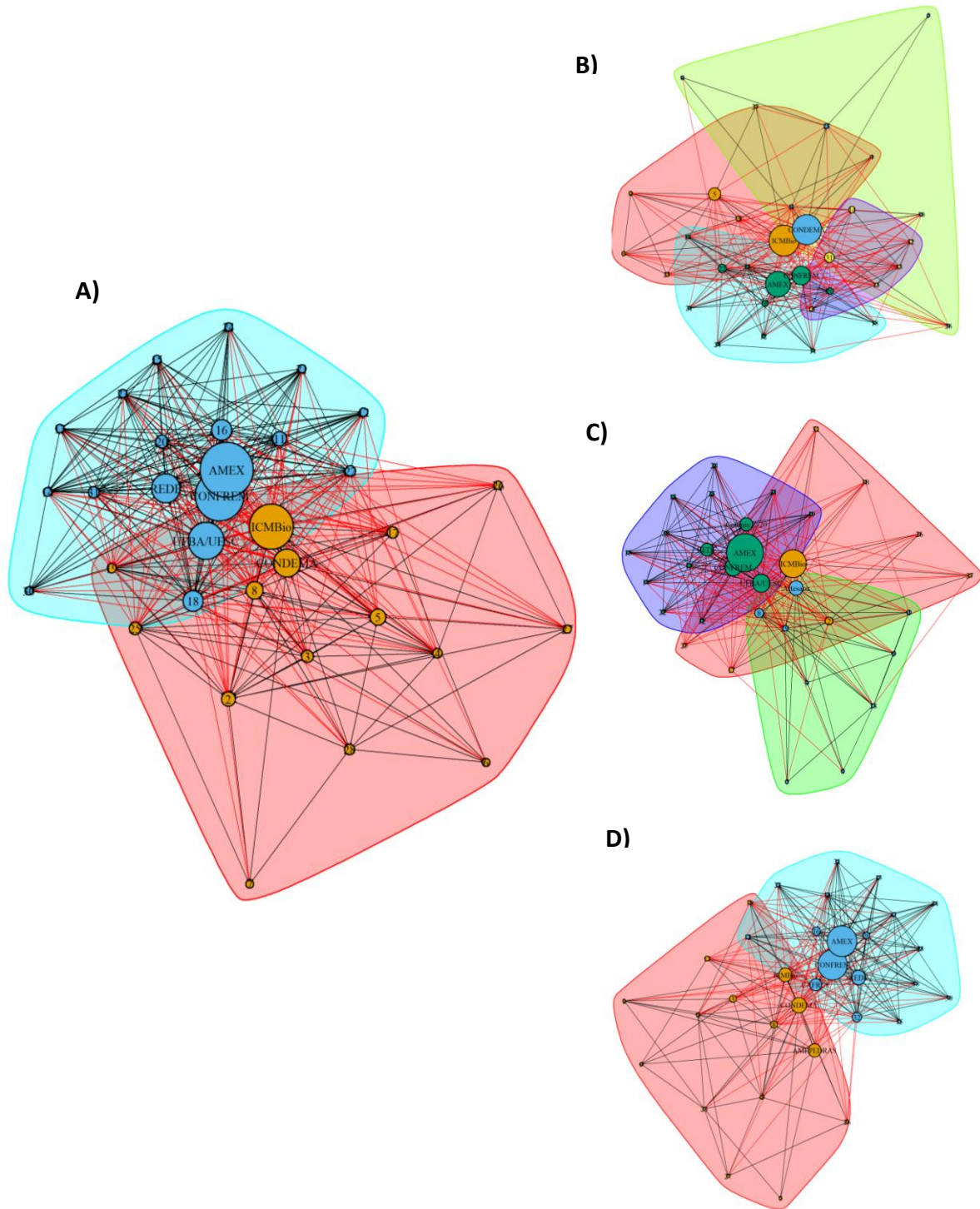


Figure 3: Subgroups structure on the collaborative management networks in the Canavieiras Extractive Reserve: A) General, B) Biodiversity, C) Governance and D) Socioeconomic networks. The colors indicate subgroups obtained by the cluster Optimal Community structure method. Node sizes are proportional to betweenness centrality values. Nodes displayed using the force-directed layout algorithm by Fruchterman and Reingold. For nodes references see (S2 Table). AMEX: Mother Association of Extractivists, CONFREM: National Commission for Strengthening Coastal and Marine Extractive Reserves, ICMBio: Chico Mendes Institute for Biodiversity Conservation, REDE: Women Network of Extractive Fishing Communities in the South of Bahia, UFBA/UESC: Federal University of

Bahia / State University of Santa Cruz, CONDEMA: Municipal Council for the Canavieiras Environment Defense, Artesãos: Segment of Artisans, Art makers and Fishing Gear, Colônia Z-20: Fishermen's association, CARFE: Family Farming Coordination, AMEPEDRAS: Association of Shellfishes and Fishermen of Pedras de Una.

In the general network (Figure 3. A), two not well defined subgroups of nodes were identified, one corresponding to a subgroup (in light-blue) of almost all the beneficiaries institutions and universities sharing more connections between them; and other subgroup (in red) represented government and civil society institutions. The same pattern was observed for the socioeconomic subnetwork (Figure 3. D).

Four overlapping subgroups were detected in the biodiversity subnetwork (Figure 3. B). One of them (the light-blue one) included just beneficiaries institutions. The other subgroups clustered different types of institutions.

In the subgroup structure of governance subnetwork (Figure 3. C), three overlapping subgroups were detected. One group (the blue one) was comprised for most beneficiaries' institutions along with one university. The others two subgroups aggregate different types of institutions, being one (the red one) more represented for the government environmental agency and civil society institutions, and the other (the green one) more represented for local government and civil society institutions.

The low modularity values obtained (Table 2) indicated poor divisions of networks into groups showing weak subgroups structure for all networks.

Table 2: Numbers of subgroups and modularity values for subgroups structure of networks in the Canavieiras Extractive Reserve. Subgroups detection was obtained by the cluster Optimal Community structure method.

Network	Subgroups	Modularity
General	2	0.122
Biodiversity	4	0.133
Governance	3	0.134
Socioeconomic	2	0.140

4. DISCUSSION

4.1 Bonding social capital

Density, reciprocity and transitivity are all different ways of measuring bonding social capital that gives an idea of the social closure or cohesion among actors in the networks.

However, in the collaborative networks evaluated these measures did not show similar tendencies.

Researchers have identified that denser networks promote the development of trust, share views, and mutual understanding reducing the risk and cost of collaborating with others, then increased levels of collective action could be achieved (BODIN; CRONA, 2009; OSTROM, 1990). Unlike that, the low density values found indicates that all the collaborative networks were sparse rather than cohesive networks. This could reflect the presence of different views and the lack of trust and common understanding for collective action among all the DC members. So, even if very high density values are not desired for collective action because they may lead to homogenization of information and knowledge; low density values (like the ones observed in this study) are not desired either, since the risk and cost of collaboration can compromise the development and maintenance of collaborative processes (BODIN; CRONA, 2009; BODIN; CRONA; ERNSTSON, 2006).

Regarding reciprocity, this measure was low for all the networks under study, indicating a limited mutual embeddedness across the institutions, which means, that there are poor levels of dyadic (two-party) collaboration. A directed tie might be interpreted as the intent of one institution to work with another in resolving a governance problem, but, only if the reciprocation of this tie occurs it should be inferred a level of substantial cooperation between the two institutions (ROBINS; BATES; PATTISON, 2011). It is supposed that a governance network that is functioning well is characterized by the presence of reciprocated network ties but not their universality (BERARDO; SCHOLZ, 2010; ROBINS; BATES; PATTISON, 2011). Nevertheless, the low levels of reciprocity found can suggest that bonding structures formed in cooperation contexts are not predominant in the network, instead, others types of bridging structures like the presence of leaders or central actors could be more relevant in the networks under study. In this sense, a central institution that better fits in a specific collective action problem will receive more interactions but, not necessarily will reciprocate the ties in the same proportion for the others institutions.

Although the networks showed low values of relational embeddedness (reciprocity), all of them showed high levels of structural embeddedness (transitivity). This suggests that the importance of the bonding social capital is primarily at the triad level, rather than a dyadic level. Even both measures indicate bonding relationships; reciprocity can support credible commitments in two-party collaborative projects, while transitive relationships are more critical for credible commitments in larger projects (BERARDO; SCHOLZ, 2010). Also, a triad can be fostered with the presence of central institutions: two institutions that are related also will seek to establish a relation with the most central institution.

4.2 Network positions and bridging social capital

Identifying the structural position that an actor has in the network is important for understanding their role. Who occupies central and peripheral positions, which attributes they have and how they act will have implications for collective action and governance outcomes (BODIN; CRONA, 2009). Actors in a centrally position may facilitate collaboration, initiate action, coordinate resources, and bring together other disconnect groups of actors, but if they are not interested or are not engage in collective action they could interfere in the others initiatives (BODIN; CRONA, 2009).

The ICMBio was the most sought institution to deal with the different problems or situations presented, demonstrating the importance of this institution for collective action. This makes sense since the ICMBio is the government environmental agency responsible for the co-management of the CER. Its central position that ICMBio occupied indicated that this institution can acts as a coordinator that facilitates collective action (BERARDO; SCHOLZ, 2010; BODIN, 2017; BODIN et al., 2020). In resource governance, it has been shown that high degree of network centralization appears positively correlated with collective action, mainly through central actors' abilities to prioritize and coordinate activities (SANDSTRÖM; CARLSSON, 2008). Yet, the effectiveness of collaboration might still fail if the central coordinator is not doing its job (BODIN, 2017). In this sense, the exercise of leadership by the ICMBio, was perceived as good by the rest of the DC members (CARDOZO et al., 2019). However, in the assessment of the quality management of the CER through the manager's lens carried out by Santos and Schiavetti (2014), the CER was classified as "inferior standard" getting its low value in the social and economic dimensions.

Even being a bottom-up community based initiative to co-management, researchers already called attention to the central role that the ICMBio has in the Extractive Reserves. They argue that this is a consequence of the implementation process of this model in the marine and coastal environment, in which a change was produced in the management responsibility of these areas: moving from traditional extractive communities to the sphere of the government's environmental agency, minimizing the idea of self-management present in the creation of the first Extractive Reserve (CUNHA; LOUREIRO, 2009; SANTOS; SCHIAVETTI, 2013). In this sense, despite of ICMBio being the most central institution, traditional communities also have a relevant role in collaborative networks, being AMEX the second most important institution sought to work with. Even AMEX not being an official DC member, this institution plays a fundamental role not just in the deliberate and decision-making process (CARDOSO et al., 2019), but also in collaborative action. As expected, beneficiaries' institutions are organized and they recognized AMEX as their leader institution with the capacity for coordinated action. Several works address that legitimate and well engaged leader institution are critical for successful co-management, providing resilience to changes in the governance (CRONA; GELCICH; BODIN, 2017; GUTIÉRREZ; HILBORN; DEFEO, 2011).

The pattern ICMBio in the head followed by AMEX as the more central's institutions was repeated in almost all the networks and indicated that both are considered key institutions that can facilitates collective action. Also, the proximity between these institutions in the networks showed that these central actors share many connections between them. This highlights that ICMBio and AMEX perceived each other like important institutions to work with. In this sense, this supports the recognition that traditional communities and government need to act together watching for the success of the co-management (ALEXANDER; ANDRACHUK; ARMITAGE, 2016).

Institutions that represent local government like municipalities and city councils, and some civil society institutions were clearly peripheral in the network. This denotes that they were not perceived like active institutions to address management problems at the CER. For the local government of Belmonte city and institutions that represent non-traditional activities, like tourism and rural producer sector, the poor engagement in collaborative action could be explained by the fact that these are new institutions that got involved in the DC over the last year. So, they still had not established much collaborative relationship with the others DC members. This emphasizes that, the time of involvement in collaboration that an institution has, and the previous experiences of collective action seem to be important attributes for choice to collaborate with another institution (NOHRSTEDT; BODIN, 2020).

Whereas, the peripheral position of local governments institutions and the Association of Canavieiras Shrimp Producers (ACCC, in Portuguese), that represent a non-traditional activity, could be a result of underlying conflict relationships. Despite of this study being focused just in positive relationships (e.g. collaboration) and did not evaluate negative relationships (e.g. conflict), cautious should be taken in considering the absence of relationship as having no relation at all (BODIN; GARCÍA; ROBINS, 2020). Another possible interpretation for the absence of relationship is to consider it as an avoiding tie that indicates a pre-existing conflict relation (ROBINS; BATES; PATTISON, 2011). Avoidance of another disliked actor is a social strategy that transmutes what would be a negative tie into the absence of a relationship (BODIN; GARCÍA; ROBINS, 2020). So, in the studied networks the poor engagement that local governments and ACCC institution have could indicate that old conflicts related to the process of CER creation are still latent (CARDOZO et al., 2019; DIAS et al., 2018). This can also be evidenced by the low participation that these institutions have in the decision making process (CARDOZO et al., 2012, 2019; DUMITH, 2018). These conflicts have its root in the lack of a common vision and objectives in relation to CER, and in the presence of different interests and concerns about who should have access to the resources and how these resources should be used and managed (DUMITH, 2018). Even opposite interests are often hard to solve; neglecting these underlying conflicts among actors can have significant implications in collective action networks, since the later may be shaped more on the basis of disputation than on cooperation (BODIN; GARCÍA; ROBINS, 2020; ROBINS; BATES; PATTISON, 2011). This means that actors could

choose their collaboration partners more strongly influenced by ongoing conflicts than by their partners having similar beliefs or interest (BODIN; GARCÍA; ROBINS, 2020).

Moreover, ignoring this conflict of interests could intensify issues of power imbalances that could hinder collective action (BODIN; GARCÍA; ROBINS, 2020). In this sense, local governments are power institutions with the capacity to mobilize financial, human and technical resources, and the fact that they occupy a peripheral position in the collaborative networks does not mean that they are not considered key institutions to work with. Most interviewed manifested the importance and the need to count with these institutions in collective actions, but they also highlighted the lack of support and recognition to the traditional extractives activities that Canaveiras and Belmonte government shows. This also was found in the works of Cardozo et al. (2019) and Dumith (2018). This lack of support translates into a lack of engagement of these institutions, which can end up obstructing collective action attempts. This became evident, a few years ago, when Canaveiras local government claimed that CER was hindered the economic development of the city and encouraged the change of the Extractive Reserve model for another conservation model more permissible that not recognizes the extractive community rights (DUMITH, 2018).

As this study revealed, the collaborative networks characterized by having different types of power institutions: the ones more solicited for collective action that occupy a central position in the network (ICMBio and AMEX), and the ones that, despite occupying a marginal position in the network, they have power because they are formal authorities (local government institutions). These two different powers institutions were also illustrated by Bodin and Crona (2008) in their study of a rural fishing village. Thus, like the authors emphasize, the collective action will depend on how the power institutions interplays and choose to collaborate.

In addition, betweenness centrality indicates how important an institution is in terms of connecting others institutions in the network. It is interesting to note that, despite of being AMEX and COFREM the more relevant institutions, these ones jointly with ICMBio, UFBA/UESC, REDE and CONDEMA form a common group of institutions that were important in all networks in terms of acting like a “bridge” connecting others institutions. In this sense, betweenness measure seems to highlight multiple institutions that play this role, evidencing a decentralization of this one. This configuration is associated with bridging social capital that arises in low risk coordination contexts (BERARDO; SCHOLZ, 2010; BODIN; CRONA; ERNSTSON, 2006; BODIN et. al., 2020).

4.3 Subgroups detection

Modularity evaluates the goodness of partitions of a network into clusters or subgroups (GIRVAN; NEWMAN, 2004). Unlike was expected, modularity values obtained were low, indicating poor partitions of the networks. In others words, this means that the number of internal edges in a cluster was low in comparison to these to the outside of the cluster, as was evidenced

by the amount of overlapping present between the subgroups. Even if the density values found indicate that the networks were sparse, none of the networks were fragmented into separated subgroups. This evidenced the existence of a bridging social capital that linked together different weakly connected groups (BODIN; CRONA, 2009). This bridging links among different and heterogeneous groups seem to be necessary to the creation of common understanding for collective action in small scale fisheries (BODIN; CRONA; ERNSTSON, 2006).

Despite of the network partition in subgroups being weak, in all networks could be differentiated a subgroup formed by all, or almost all, the beneficiaries institutions. This denoted the bonding social capital existent among traditional communities (BODIN; CRONA, 2009). Highlights that, beneficiaries are engaged among them for collective action even being a heterogeneous group (formed by representatives of geographically separated communities that play different artisanal fisheries and others extractive activities). The organization of this group and the cohesion of theirs goals and purposes were emphasized in the studies of Prost (2018) and Cardozo et al. (2019). In this case AMEX institution act as an engaged leader that bring others beneficiaries institutions together to reinforce the cohesion necessary for collective action. This type of close bonding structure would favors mutual trust, commitment and exertion of social control (BERARDO; SCHOLZ, 2010), and it is of huge importance since, the absence of self-organization, the limited participation and a lack of a sense of community are among the factors that cause failures in community-based resource management (ALEXANDER; ARMITAGE; CHARLES, 2015). Thus, some level of social cohesion among the traditional resource users is necessary for the maintenance of key social processes that support effective resource governance (ALEXANDER; ARMITAGE; CHARLES, 2015; ALEXANDER; BODIN; BARNES, 2018). However, it is important to be cautious since such strong cohesiveness among actors of the same type, could help to reinforce the idea of “us and them,” that might result in the amplification of conflicts between different groups hindering collective action (ALEXANDER; ARMITAGE; CHARLES, 2015; BODIN; CRONA, 2009; BODIN; CRONA; ERNSTSON, 2006).

It is interesting to note that the Universities are grouped with beneficiaries. This could indicate that these institutions work together and are aware of the importance of exchange traditional with technical and scientific knowledge for addressed management problems (BODIN; CRONA; ERNSTSON, 2006). This joint work was evident in the recently formulation of the Guaiamum (*Cardisoma guanhumi*) management plan. It is important for the resilience of the system that heterogeneous actors (with different educational backgrounds, roles, and occupations) work together since it facilitates learning about complex problems (BODIN; CRONA; ERNSTSON, 2006). On the contrary, actors interacting only within their own subgroups could contribute to the reinforcement of current perceptions, hindering the possibilities of emerge new ideas, and that, could be detrimental for achieving management problems (BODIN, 2017).

4.4 Subnetworks: what shapes collaboration ties?

The fact that almost all the subnetwork showed similar values for estimated statistics and the same institutions occupying central positions highlight that there are different factors shaping the relations in collaborative action besides the problem to be solved. Then, what can be influencing the decision about with whom an actor chooses to engage in collective action?

By one hand, it seems that institutions prefer to collaborate with others who have similar interests and objectives and are perceived as knowledgeable and trustworthy (homophily). Because of this, can be seen coalitions of these institutions, like the one form by beneficiaries, which seems to be useful in CER to pursue their goals in policy processes (CARDOZO et al., 2019).

On the other hand, it seems that the attributes that makes an institution more attractive, as the capacity to provide human, financial and technical resources (BERARDO; SCHOLZ, 2010; BODIN, 2020), can also be a factor influencing these networks. In this line, seems to be “generalist institutions” (like ICMBio and AMEX) that are perceived with the capacity to provide different types of resource to solve a wide range of problems, and “specialist institutions” that are perceived as needed so solve specific problems. The latter was evident in the importance that some institutions received for collaborate in some particular problems. For example the university seems to be more solicited to resolve problems related to monitoring contamination of mangroves and waters, and carry out the monitoring of species of socioeconomic interest; and the Navy was more solicited in surveillance issues. Also can be possible that an institution choose others to collaborate with based on the role that another institution has or under the perception that the other institution “has the obligation or the responsibility” to solve certain problems, this could explain in part why the ICMBio was so sought. All of this supports the idea of Nohrstedt and Bodin (2020) recent work, that argues that actors’ tendencies to engage in collective action is mainly determined by their perceptions on who of their potential collaborators will provide a better fit solving the problems, and less on the nature of the collective problem itself. Furthermore, the authors stressed that social tie formation in collective action can be explained both by actors’ task engagements, and actor attributes associated with leadership, professionalization, and experience.

4.5 Implications for collective action and resilience

Researchers agree that exist a series of tradeoffs inherent in network structure and function and, for instance, there is no single governance network structure that is “ideal” for collective action in community-based co-management (ALEXANDER; ANDRACHUK; ARMITAGE, 2016; BODIN, 2017; BODIN; CRONA; ERNSTSON, 2006). The collaborative networks found in the CER have structural elements of both bonding and bridging social capital. But, how the networks structures found affect collective action and which implications may they have in the resilience of the CER co-management?

The fact that ICMBio was the most demanded institution to solve any one of the collective actions problems highlight a certain degree of dependency on State' human, financial and technical resources. Even if the co-management is well established in the decision-making arena (with stable decision forums and clear rules about how the decisions are made and that ensures the participation of different actors and respect the rights and opinions of traditional communities) it seems like, in the process of moving from discussion to collective action almost everything remains in the ICMBio hands. It appears that, in practice, the power share characteristic of the co-management disappear, giving place to a more hierarchical management. So, in spite of ICMBio can act as a coordinator for collective action its central position may have certain implications. First, it is good to acknowledge that the ICMBio, even if in this study was regarded as a unity, it has many faces associated with different groups and functions (CARLSSON; BERKES, 2005). The recent study of Prado, Castro and Seixas (2019) highlights the cross-jurisdictional mismatch between local and national ICMBio offices, related to its vertical and highly bureaucratic structure. Also, like the authors stress, this institution depends on the Brazilian Ministry of Environment, so it is directly influenced by the national government political agenda. In this sense, Cardozo et al. (2019) reports the little attention received and the slow response time of the ICMBio, which can interfere with the level of trust reducing the degree of participation of the community. Also, Dumith (2018) reports that the several changes that occur in the environmental agencies, as a result of mergers of secretaries and ministries, are constantly straining the traditional communities in the CER. Then, the initiatives for collective action can get caught in this central structure and the translation from discussion to practice being hindered or delayed.

Moreover, remembering that institutions are made of people, the role of the local manager gain relevance for the hybrid position that has between the state and the communities (PRADO; CASTRO; SEIXAS, 2019). However, often the pressures that the ICMBio' manager suffers, quickly wears managers down and as a result many of them leave this job, and with this the relationships that have been built break down (PRADO; CASTRO; SEIXAS, 2019). Dumith (2018) also recognizes this problem, reporting that in ten years of the CER foundation seven managers have already passed after numerous disagreements between them and communities. So, the strength collaborative relation that can be seen between ICMBio and AMEX that involves trust, common vision and objectives did not arise spontaneously, although was evolved and consolidated over time (CARDOSO et al., 2012). It is important to stress that when institution leader's change; those strong relational ties could disappear having consequences for the co-management (ALEXANDER; ARMITAGE; CHARLES, 2015). Even more cautiously have to be if this institution occupies a central position in the network (BODIN; CRONA; ERNSTSON, 2006). In this sense, it is important the existence of an alignment between the ICMBio managers responsible for the co-management of the CER, so that in the event of a change of a manager, the mutual understanding and relationship with AMEX is not lost. Then, this high dependency of ICMBio can have implications for the dynamic and adaptive co-management compromising the resilience of the socio-ecological system.

In spite of that, the robust social capital of the traditional communities with the AMEX as a leader and the decentralization in the bridging role, were others beneficiaries institutions like CONFREM and REDE gain relevance, can act as a buffer against crises and changes in institutional arrangements fostering sustainable co-management systems (CRONA; GELCICH; BODIN, 2017; GUTIÉRREZ; HILBORN; DEFEO, 2011). The capacity that the beneficiaries group has to organize was evident in the socioeconomic dimension. In this sense, the traditional communities are organized in the formulation of different community projects relate to improve the quality of life, the diversification of income source, and add value to the production chain. It seems that this organizational experience gives them the ability to deal with changes and difficulties that the CER faced in a short time interval, like was the oil spill arrival on the Canavieiras coastlines and mangroves, and the SARS-CoV-2 Pandemic. Thus, the organization in collaborative actions to face these problems enabled the reinforcement in their interactions, conferring social resilience to the socioecological system.

Also, the fact that AMEX chose not to belong to the DC is a political decision, which aims to strengthen the voice and vote of small fishers and shellfish associations existing in the region. The implication of not being on the DC does not reflect the institution's participation in governance, but its absence makes it possible for new leaders to appear.

5. CONCLUSION

This study adopts the premise that how actors engage will determine certain network structures and that this would shapes the different co-management process and outcomes. Based on that, this study analyzes the collaborative networks among the institutions involved in the CER co-management, formed to solve biodiversity conservation, governance and socioeconomic problems.

The networks found show bonding and bridging structures denoting the presence of social capital and leadership necessities for collective action. The ICMBio was the most demanded institution to solve the different problems presented in part because it is the agency in charge of the co-management of the reserve. This institution can coordinate actions, since it has the capacity to provide different resources, but on the other hand, this institution can act delaying or hindering collective action due to its hierarchical and bureaucratic structure.

The social capital was low among all DC institutions, which can indicate the presence of different perceptions and understanding about collective action. Nevertheless, the social capital was high among the beneficiaries' institutions (homophily) denoting that they are organized and that they recognized AMEX as their leader. Also, AMEX was the second most important institution sought to work with, having a strength relationship with ICMBio, reinforcing the idea that traditional community and government need work together ensuring the success of co-management.

The networks structures denoted certain decentralization in the role of “bridge” actor, in which, in addition to ICMBio and AMEX, others institutions representing the beneficiaries sector such as CONFREM and REDE acquire relevance to connect other institutions. This indicates the presence of social capital and well-engaged leaders, essential for the success of co-management as they provide resilience to changes in the governance of the socio-ecosystem

The local governments occupy a peripheral position in the network denoting a poor engagement of these institutions that could indicate the presence of conflicts. The absence of a cooperative intent by local governments hindered the collective action. Despite of that, several interviewed manifest the importance and the need to count on these institutions in collective actions.

Even if the networks were sparse the levels of network fragmentation were low indicating that heterogeneous actors are knitting together to foster the social capital. This interaction among heterogeneous actors with different educational backgrounds, roles, and occupations, facilitate the exchange of knowledge and learning about the complex social and ecological nature of the system fostering the resilience.

It should be stressed that the networks described in this study are static representations of a dynamic social process. However, collaborative networks are not static and they continually evolving as actors adjust to different endogenous and exogenous drivers of change (ALEXANDER; ANDRACHUK; ARMITAGE, 2016; BODIN; SANDSTRÖM; CRONA, 2017); then, long-term studies should be necessary for understand this dynamics.

Remarkably this study arouses a set of questions that furthers studies should be tent to address. Future efforts are needed to determine the statistical validity of the structures that form the networks. In addition, it would be interesting moving beyond collaborative relationship via the examination of both facilitating and hindering ties with the attempt to elucidate whether there are cooperative or conflicting relations that predominates shaping the collective action networks. Further investigation into which factors, whether an actor’s attributes or the nature of the collective action-problems, influences the choice of an institution engaging with one another in collective action will be necessary for understanding the patterns found. Also, simply establishing a collaborative network is not a guarantee that collective action problems will be effectively addressed, so linking these collaborative networks with outcomes should be of interest to evaluate the success of the network configuration in achieving collective action.

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8. SUPPORTING INFORMATION

S1 Questionnaire

Which other member institutions of the Deliberative Council would you count to:

Biodiversity conservation issues related to CER

- A. Act in the case of new shrimp farming enterprises request permission to settle in the CER region?
- B. Monitoring the pollution and contamination of mangroves and estuaries at CER?
- C. Carry out the monitoring of species of socioeconomic interest at CER?
- D. Change the ban fisheries periods of species of socioeconomic interest at CER?

Governance issues related to CER

- E. Reach the information from the discussions of the Deliberative Council to the communities, and the demands of the communities to the Deliberative Council?
- F. Solve the problem of surveillance of vessels from non-beneficiaries who fish at the CER area?
- G. Strengthen the effective participation of the Deliberative Council members in the discussions of the CER?
- H. Guarantee to beneficiaries the free access to the beaches and mangroves at CER?

Socioeconomic issues to CER

- I. Involve young people in the CER projects?
- J. Implement tourist activities at the CER?
- K. Develop projects that add value to the products extracted / generated at the CER?
- L. Improve the quality of life and income of the extractives communities of the CER?

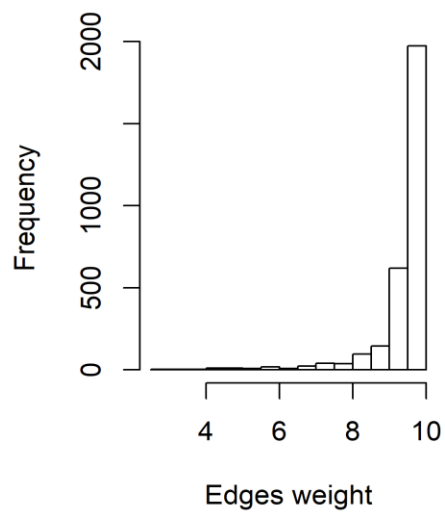
S2 Table: Institutions involved in the Canavieiras Extractive Reserve co-management. GOV: government, BEN: beneficiaries, CS: civil society. The member institutions of the Deliberative Council (DC) correspond to the 2020-2022 period.

Id	Institutions (Networks nodes)	Institution types	Description	DC member
1	ICMBio (Instituto Chico Mendes de Conservação da Biodiversidade)	GOV	Governmental environmental agency	yes
2	MARINHA (Capitania dos portos de Ilhéus)	GOV	Marine police institution	yes
3	INCRA (Instituto Nacional de Colonização e Reforma Agrária)	GOV	Governmental agriculture agency	yes
4	Câmara de Vereadores Canavieiras	GOV	Local Council Government	yes
5	Prefeitura de Canavieiras	GOV	Local Government	yes
6	Prefeitura de Belmonte / Câmara de Vereadores Belmonte	GOV	Local Government	yes
7	Câmara de Vereadores Una	GOV	Local Council Government	Yes
8	Prefeitura de Una	GOV	Local Government	yes
9	REDE (Rede de Mulheres de Comunidades Extrativistas Pesqueiras do Sul da Bahia)	BEN	Traditional Fisheries and Extractive Activities	yes
10	CONFREM (Comissão Nacional de Fortalecimento das Reservas Extrativistas Costeiras e Marinhas)	BEN	Traditional Fisheries and Extractive Activities	yes
11	CAFRCE (Coordenação de Agricultura Familiar)	BEN	Traditional Fisheries and Extractive Activities	yes
12	APESCC (Associação dos Pescadores e Catadeiras de Camarão de Canavieiras)	BEN	Traditional Fisheries and Extractive Activities	yes
13	AGGC (Associação dos Goiamunzeiros e Goiamunzeiras de Canavieiras)	BEN	Traditional Fisheries and Extractive Activities	yes
14	AMPB (Associação das Marisqueiras e Pescadoras de Belmonte)	BEN	Traditional Fisheries and Extractive Activities	yes
15	ATCCC (Associação dos Tiradores e Catadeiras de Caranguejo de Canavieiras)	BEN	Traditional Fisheries and Extractive Activities	yes
16	Colônia Z-20	BEN	Traditional Fisheries and Extractive Activities	yes
17	Pescadores Belmonte (Colônia de Pesca Z21, Segmento dos Goiamunzeir@s e Associação de Pescadores)	BEN	Traditional Fisheries and Extractive Activities	yes
18	Segmento dos Artesãos, Confeccionadores de Artes e Petrechos de Pesca	BEN	Traditional Fisheries and Extractive Activities	yes
19	APMO (Associação de Pescadores e Moradores de Oiticica)	BEN	Traditional Communities	yes
20	APEMA (Associação de Pescadores, Extrativistas e Moradores de Atalaia)	BEN	Traditional Communities	yes
21	AMAPPP (Associação de Moradores, Agricultores e Pescadores de Puxim da Praia)	BEN	Traditional Communities	yes
22	APAC (Associação de Pescadores e Agricultores de Campinhos)	BEN	Traditional Communities	yes
23	APPS (Associação de Pescadores de Puxim do Sul)	BEN	Traditional Communities	yes
24	APEMBAVE (Associação de Pescadores e Moradores da Barra Velha)	BEN	Traditional Communities	yes
25	AMEPEDRAS (Associação de Marisqueiras e Pescadores de Pedras de Una)	BEN	Traditional Communities	yes
26	ACOMCAN (Associação dos Comerciantes e Moradores da Orla de Canavieiras) / CLUPECANES (Clube de Pesca Esportiva de Canavieiras)	CS	Non-traditional activities: Tourism	yes

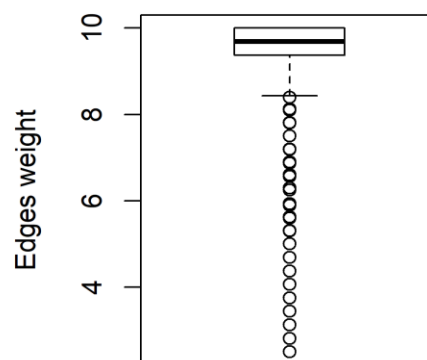
27	Apicultura (Segmento Apicultores+ACAP e COAPER)	CS	Non-traditional activities: Rural Producer	yes
28	ACCC (Associação dos Criadores de Camarão de Canavieiras)	CS	Non-traditional activities: Rural Producer	yes
29	CONDEMA (Conselho Municipal de Defesa do Meio Ambiente de Canavieiras)	CS	Public Policy Collegiate	yes
30	CI (Conservação Internacional)	CS	ONG	yes
31	UFSB (Universidade Federal do Sul da Bahia)	CS	University	yes
32	UFBA (Universidade Federal da Bahia) / UESC (Universidade Estadual de Santa Cruz)	CS	University	yes
33	AMEX (Associação Mãe dos Extrativistas)	BEN	Traditional Fisheries and Extractive Activities Sector	no

S3 Figure: Central tendency measures for edge weight. A) Accumulated frequency for edges weight values. B) Box plot of the edges weight (mean value= 9.462 ± 0.892)

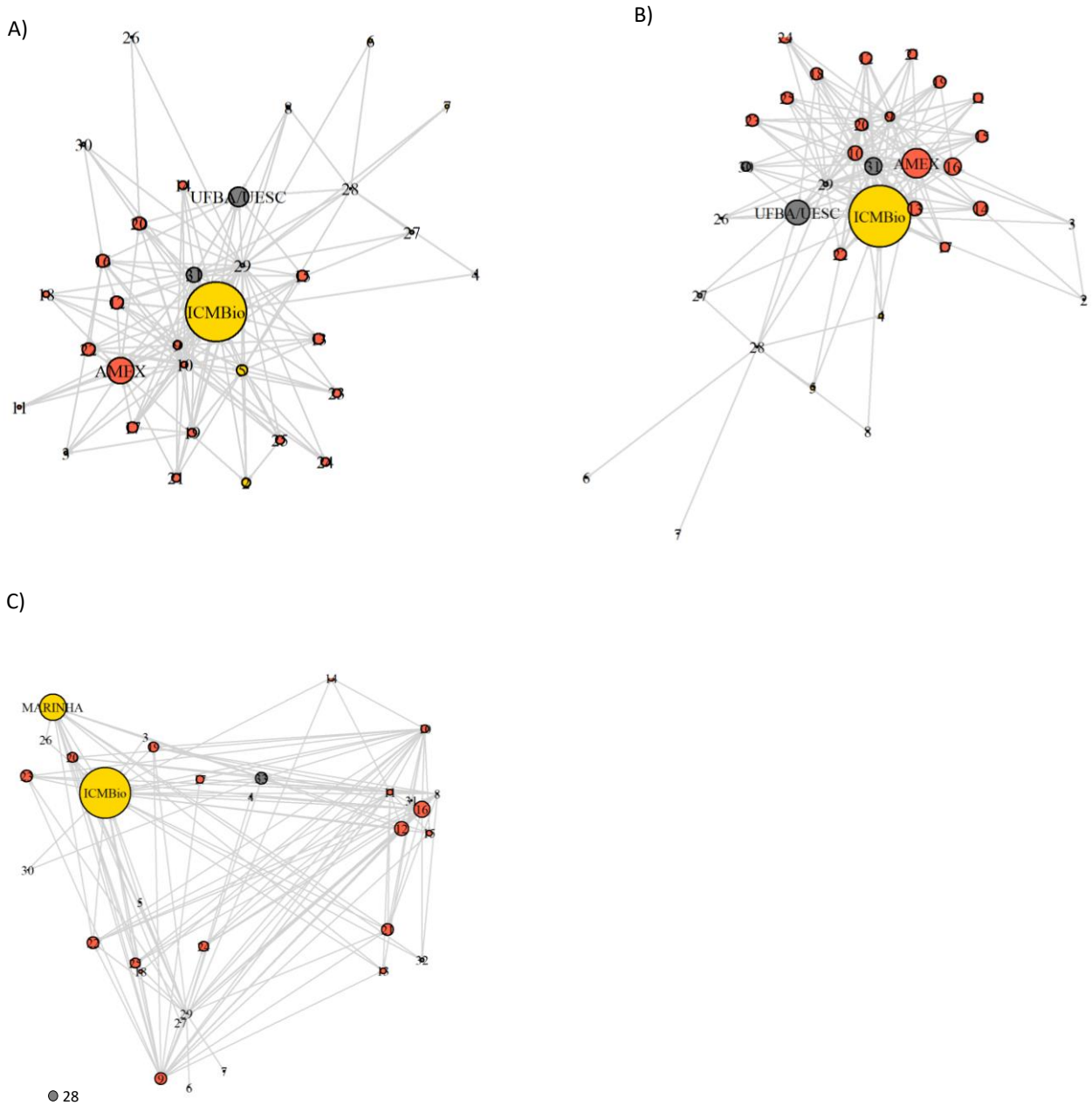
A)



B)



S4 Figure: Network visualization for the collaborative networks formed to resolve specific problems in the Canavieiras Extractive Reserve: A) Monitoring pollution and contamination of mangroves and estuaries, B) Monitoring of species of socioeconomic interest and C) Surveillance of vessels from non-beneficiaries who fish at the CER area. Nodes colors represent the different types of institutions (red = beneficiaries, gray = civil society, yellow = government). Node sizes and edges width are proportional to the in-degree centrality values and interaction priority, respectively. The networks were displayed using the force-directed layout algorithm by Fruchterman and Reingold showing nodes that share more connections closer to each other. For number references of nodes see (S2 Table). AMEX: Mother Association of Extractivists, ICMBio: Chico Mendes Institute for Biodiversity Conservation, UFBA/UESC: Federal University of Bahia / State University of Santa Cruz; MARINHA: Navy.



CONCLUSÃO GERAL

Este estudo assumiu que os atores envolvidos e a maneira como estes se engajam determinam certas estruturas na rede, e que estas estruturas modelam diferentes processos e resultados da cogestão. Com base nisso, foram analisadas as potenciais redes de colaboração entre as instituições envolvidas na cogestão da Reserva Extrativista de Canavieiras, formadas para resolver problemas relacionados à 1) conservação da biodiversidade, 2) governança e 3) socioeconomia.

As redes analisadas apresentaram tanto estruturas de ligação como estruturas de ponte, indicando a presença de capital social e liderança, necessários para alcançar a ação coletiva. Tal como esperado, o ICMBio foi a instituição mais procurada para resolver os diferentes problemas apresentados. A posição central desta instituição na rede promove a ação coletiva, já que a mesma possui a experiência e a capacidade de fornecer diferentes tipos de recursos e serviços. Porém, essa centralização também pode fazer com que as demais instituições tenham um alto grau de dependência do ICMBio para lograr a ação coletiva, o que, somado a estrutura vertical e hierárquica desta instituição, pode agir tardando ou dificultando a ação coletiva. Essa demora ou dificuldade para agir podem então gerar desconfiança em relação ao ICMBio e ao processo de governança colaborativa, desmotivando as comunidades tradicionais a participar.

O capital social estimado considerando toda a rede foi baixo, o que pode indicar falta de confiança e presença de diferentes percepções e entendimentos, os quais dificultariam a ação coletiva. No entanto, o capital social foi alto quando consideradas apenas as instituições de beneficiários, indicando a unidade deste grupo, que reconhece a AMEX como sua liderança. Além disso, a AMEX foi a segunda instituição mais solicitada para trabalhar em ação coletiva.

O ICMBio e a AMEX se relacionam fortemente entre si, e se percebem como instituições parceiras com as quais trabalhar em conjunto. Ambos parecem dar importância ao fato de que as comunidades tradicionais e o governo precisam atuar em conjuntamente, zelando pelo sucesso da cogestão.

As estruturas das redes demonstraram uma descentralização no papel de ator ponte, no qual instituições representantes dos beneficiários como CONFREM e REDE adquirem relevância para conectar outras instituições. Isto indica a presença de capital social e líderes bem engajados, essenciais para o sucesso da cogestão por conferirem resiliência às mudanças na governança do socioecossistema.

O governo local ocupa uma posição periférica na rede, indicando um fraco engajamento dessas instituições e sugerindo que antigos conflitos relacionados ao processo de criação da CER ainda podem estar latentes. A ausência dessa intenção cooperativa por parte do governo local dificulta a ação coletiva, mas apesar disso, vários entrevistados manifestam reconhecer a importância e a necessidade de contar com essas instituições nas ações coletivas.

Ao contrário do que era esperado, mesmo que as redes tenham sido relativamente esparsas, seus níveis de fragmentação foram baixos, indicando que atores heterogêneos estão unidos para fomentar o capital social. Essa interação entre atores heterogêneos, com diferentes origens educacionais, funções e ocupações acaba facilitando a troca de conhecimento e a aprendizagem sobre o socioecossistema, aumentando sua adaptação e resiliência.