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ISSF WORKSHOP ON DIFFERENT APPROACHES to Limit the Number of FADs in the Oceans:

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Abstract

At its October 2022 meeting, the ISSF Scientific Advisory Committee recommended that ISSF convene a workshop with a small group of experts to consider different principles of economic theory which could be used to make Fish Aggregating Devices (FAD) limits more effective. The rationale for such a workshop was that the use of FADs, both drifting (dFAD) and anchored (aFAD), has a number of known impacts on target tuna stocks, non-target species and the broader ecosystem. Limiting the number of FADs in each Ocean region, together with other measures such as biodegradable FADs, can be a tool to address several, if not most, of these impacts. Recommendations are given on actions that can be taken to incentivize fewer FAD deployments and higher rates of FAD recovery.

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The International Seafood Sustainability Foundation (ISSF) — a global coalition of seafood companies, fisheries experts, scientific and environmental organizations, and the vessel community — promotes science-based initiatives for long-term tuna conservation, FAD management, bycatch mitigation, marine ecosystem health, capacity management, and illegal fishing prevention. Helping global tuna fisheries meet and maintain sustainability criteria to achieve the Marine Stewardship Council certification standard is ISSF's ultimate objective. To learn more, visit iss-foundation.org, and follow ISSF on Facebook, Twitter, Instagram, YouTube, and LinkedIn.

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1. Background and Objectives

At its October 2022 meeting, the ISSF Scientific Advisory Committee recommended that ISSF convene a workshop with a small group of experts to consider different principles of economic theory which could be used to make Fish Aggregating Devices (FAD) limits more effective. The rationale for such a workshop was that the use of FADs, both drifting (dFAD) and anchored (aFAD), has a number of known impacts on target tuna stocks, non-target species and the broader ecosystem (Dagorn et al. 2013). Limiting the number of FADs in each Ocean region, together with other measures such as biodegradable FADs, can be a tool to address several, if not most, of these impacts. Currently, drifting dFAD limits are set through tuna Regional Fisheries Management Organizations (tRFMO) regulations that limit the number of actively monitored satellite buoys in the Indian, Atlantic and Pacific Oceans together with related regulations such as satellite buoy (re)activation/deactivation rules. Those satellite buoys are attached to dFAD structures to follow their trajectories and provide a rough estimation of the biomass aggregated underneath (Lopez et al., 2014). For aFADs, the limits are set by national regulations. The tRFMO active[1] dFAD limits are an indirect way of limiting total number of dFAD at sea because many dFADs remain in the water after buoys are deactivated, especially if there are no requirements to retrieve lost or abandoned FADs (Escalle et al. 2019).

Workshop Goal: Consider approaches to private and public policy that integrate technical, command-and-control, and incentive-based approaches to comprehensive and integrated FAD management. In short, what are the different ways to implement a limitation in the number of FADs in the ocean with a special focus on incentives?

Workshop participants were Rohan Currey, Laurent Dagorn, Josh Graff-Zivin, Susan Jackson, Jon Lopez, Gala Moreno, Hilario Murua, Dan Ovando, Victor Restrepo (Chair), Gerald Scott and Dale Squires, all of whom contributed their own expertise which does not necessarily represent the views of their employers. The workshop was run with the Chatham house rules, where participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed.

2. FAD Impacts

The various FAD impacts and actions to mitigate them are generally well known (see for example Restrepo et al., 2019) and it was not the purpose of the workshop to conduct a thorough review.

The workshop loosely classified impacts into fishery (direct) and environmental (indirect) ones. Fishery impacts include increased catchability of target tunas. Provided that sustainable fishing practices are conducted, this can be positive because tunas, particularly skipjack, become more available to the fishery where they were not as available before FAD use. Thus, FAD use can be an economic driver of the system, as FADs increase catchability and profitability and, in some cases, reduce fuel consumption. On the other hand, FADs can also lead to overcapacity of purse seine fleets. The other main type of fishery impacts is increased catchability of some vulnerable non-target species, particularly silky sharks, and undesirably small target tunas like small individuals of bigeye and yellowfin. These impacts are generally negative, although in some limited cases they could be positive such as increased catchability of marketable non-tuna species that are of no conservation concern (Amandè et al., 2010, 2017).

Indirect effects of FAD use are environmental ones, all of which can be considered to be negative. These include ghost-fishing (which may have been greatly reduced since all RFMOs now require dFADs to have low likelihood of entanglement or to be completely non-entangling), plastic pollution and stranding in vulnerable marine habitat. Indirect effects may also include an

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[1] By "active FAD" it is understood that the dFAD has been deployed, the satellite buoy has been activated, and it is transmitting its location and is being tracked by the vessel, its owner, or operator.

increase in the number of floating objects (natural + FADs) in the water, but the possible consequences of original habitat changes on tuna ecology are not yet demonstrated.

Monitoring a variety of FAD fishery indicators of different nature is necessary to track the various impacts over time in a holistic manner (see for example Lopez et al., 2022), but they are often confounded by what happens in other fisheries and the time lag of the stock assessment processes which are unable to detect the direct effects of FAD tRFMO regulations immediately.

The workshop noted that limiting the number of FADs addresses several of the negative impacts listed above, simultaneously. However, there are no clear management objectives to guide what the FAD limits should generate in terms of impacts. Current active FAD limits are not based on management objectives nor are they science-based; they are a response to pressure from environmental NGOs and competing gears, moderated by the interests of the purse seine fleets. FAD limits could indeed be science-based and respond to specific management goals, but the data necessary are only starting to be made available to tRFMO science bodies.

The workshop also noted that there are other actions that can mitigate several of the negative indirect impacts simultaneously. Notably, moving towards dFADs that are constructed of mostly/fully with biodegradable materials and non-entangling designs will greatly reduce pollution and stranding impacts, including beaching, and will eliminate the potential entanglement of non-target species like sharks and turtles (Moreno et al. 2023). All tRFMOs seem to be progressing in this direction and, importantly, some fleets are implementing this practice voluntarily, deploying a given percentage of their dFADs made mostly of biodegradable materials.

Finally, the workshop recognized the limitations of current data collection and compliance mechanisms with regard to dFAD construction, deployments, limits and environmental damage. FAD marking and identification and establishment of ownership rules also need to progress in order for mitigation of the negative impacts to be implemented effectively.

3. Current State of RFMO FAD Limits

The number of dFADs at sea are currently indirectly limited by the RFMO regulations summarized in Table 1.

Table 1. Summary RFMO regulations that directly or indirectly affect the number of FADs at sea. The main regulations are listed under each RFMO. Note that while some regulations are already adopted, various measures are not yet in force, so this table is not exactly a snapshot of the current situation.

MEASURE	**IATTC** Res. C-21-04	**ICCAT** Rec. 22-01	**IOTC** Res. 19/02 and 23-02	**WCPFC** CMM 2021-01
Limit # active buoys per vessel	Yes	Yes	Yes	Yes
Limit # buoy purchases per year	No	No	Yes	No
Require a level of FAD retrieval	Yes	No	Yes (in 23-02)	No
Limit supply/support vessels	Yes - Prohibit	Yes	Yes (19/02); Prohibit (23-02)	Yes - Prohibit
Encourage FAD biodegradability	Yes	Yes	Yes (19/02) Timeline for 100% (23-02)	Yes
Spatio-temporal total or FAD closures	Yes	Yes	Yes (in 23-02)	Yes
Buoy (re)activation-deactivation rules	Yes	No	Yes	Yes

As implemented, these requirements are not uniform across tRFMOs. For example, limits on active dFADs are 300 in ICCAT and IOTC, 350 in WCPFC and variable for class 1-6 vessels in IATTC (66-400 in 2022 to 50-340 in 2024); limits on buoy purchases apply in IOTC only; biodegradability is encouraged but not required in all tRFMOs except IOTC where a transition towards 100% biodegradability by 2027 is required; FAD retrieval is only mandatory in IOTC and in IATTC only during a limited period before the closure; supply/support vessels are only allowed, with limitations, in ICCAT and IOTC. In addition to these and other differences, compliance and enforcement are generally limited and monitoring and enforcing what happens at sea is difficult.

The workshop noted that none of the tRFMOs regulate the deployment of FADs. Limits on the number of active dFADs are convenient because verification of the compliance of active buoy limits is feasible and practical, as the main three satellite buoy providers can easily provide the information each tRFMO or flag State requires in standard formats.

The workshop also noted that there are voluntary initiatives that some fleets have been taking. For example, the so-called FAD Watch program in the Indian Ocean that reports on dFADs that will strand in the Seychelles reefs to organizations that can retrieve them (Zudaire et al. 2018).

DFAD limits and other regulations have, in some cases, promoted the development of Network Effects whereby all of the dFADs in a given company are managed centrally and assigned to individual vessels in the fleet. From an economic point of view, this increases economic efficiency by lowering unit production costs. From an environmental point of view, this could be seen as positive as dFAD sharing reduces the number of lost and abandoned dFADs and lowers the overall operating costs.

4. Alternative or Complementary Approaches for Effective FAD Limits

The workshop found it convenient to map policy and management objectives when thinking about potential alternatives or additional steps for FAD management. In this sense, the workshop identified two objectives:

- Reduce the environmental impact of any individual FAD. For example, through biodegradability and FAD retrieval requirements.
- Limit the overall number of FADs at sea. This addresses both environmental and fishery impacts.

The workshop considered dFADs as being comprised of three different assets: The dFAD itself, the buoy, and the information the buoy provides. Many of the ideas presented in this report are based on the notion that, of these three, by far the most valuable is the information that the buoys provide to inform the fishing strategy of the fleet controlling the dFADs.

The workshop identified a range of possible approaches to assist in limiting the number of dFADs at sea, which are presented in the following sub-sections. These range from voluntary to mandated, from simple to complex and ambitious. Some approaches seem more feasible and could be implemented in the short-medium term while others will require a series of changes to happen and a longer timeframe for implementation. For any of them, the following are conditions that, if present, would increase the effectiveness of the alternative approaches, as well as of the existing tRFMO measures:

- Comprehensive dFAD and buoy registers.
- High-resolution-operational reporting of FAD information at a regional (tRFMO) level, near real-time (within months).
- Clear dFAD/buoy ownership rules that eliminate or greatly reduce free riders and assign rights, obligations, and responsibilities.
- More transparent compliance processes that include sanctions.
- Remote buoy deactivation/reactivation not allowed.

Regarding the second bullet point above, the workshop decided that explaining in more detail would be useful as not all RFMOs require operational-level data: access by RFMOs, not individual CPCs (because they do not have region-wide data for other flags), to multiple key high-resolution datasets such as satellite-linked echosounder buoys, observer information, logbooks, as well as VMS information, if cross-referenced to each other, could help improve both FAD-related science-advice and monitoring and compliance of activities. For example, from a scientific point of view, the relationship between number of deployments, active buoys at sea and total FADs at sea could be better understood to inform management. Vessel-specific FAD-related activities (e.g., deployments, visits, and sets on monitored/unmonitored FADs) could also be better monitored, controlled and regulated, potentially improving compliance aspects of the FAD fishery. Such a dataset would also facilitate the monitoring, assessment, and management of pelagic ecosystems (Moreno et al., 2016). Data from echosounder buoys show potential to provide useful fishery-independent indices of abundance (Santiago et al., 2019). However, relying on CPCs or other entities to store and maintain these datasets could result in the loss of this important data resource over time as well as provide only partial access to the necessary data for a complete analysis of key studies. Reporting of historical data of high-resolution buoy data is also recommended to improve the representativeness of the information and the interpretation of time-series analyses.

4.1 Incremental Improvements from the Status Quo

RFMOs should consider stepwise changes instead of aiming for perfection at the onset. Develop gradual, simple, enforceable, inexpensive rules as a first step and then improve it. Such an adaptive and incremental approach allows learning and reduces costs due to risk and uncertainty. Pilot projects will help acceptance and implementation. Thus far, RFMO dFAD regulations have not been that. Instead, they tend to be convoluted, subject to interpretation and difficult to enforce.

A list of steps that could be taken is given below, in no particular order. Some solutions will likely be region-specific.

- Improve compliance and enforcement of what RFMOs already require, noting the difficulty of determining what happens at sea.
- Promote and accelerate biodegradable FAD requirements. This action will immediately deal with several impacts and opens the door to easier implementation of other measures. It could even reduce the need for other measures, e.g., reducing retrieval needs. Complaints about costs are likely unreasonable as FAD costs are nothing relative to the vessel operations and to the cost of echosounder buoys. Consider reward (R) systems where the use of biodegradable FADs reduces other requirements, such as the level of retrieval required for a vessel. Similar systems could also be applied with credits in mind (i.e., the use of biodegradable FADs could provide additional access to other requirements).
- Consider penalty (P)-reward (R) tradeoffs between dFAD numbers and dFAD sets. For example, a lower dFAD limit for a vessel may allow for a higher number of sets for that vessel, provided it remains within a stock-specific catch or effort limit. Also, a higher set limit could be allowed for vessels that deploy only biodegradable dFADs.
- Consider a Deposit/Return-like system where the limit on dFADs for a vessel one year is somehow related to the number of dFADs retrieved in the previous year (P/R). A variation on this could include an insurance system whereby fishers pool part of their allocated limits.
- Consider how penalties for stranded dFADs could be used for a retrieval "bounty" (P/R).
- Consider the role that buoy providers can play in monitoring schemes based on active buoys.
- Consider how other organizations such as MARPOL and the RFMOs could collaborate on mitigating marine debris from aFADs and dFADs, much like some tRFMOs do in collaborating with other organizations on conservation matters (e.g., CITES, IUCN).
- Require dFADs/buoys to be transferred (to another fleet or to an entity like an NGO that will then assume responsibility, use and/or retrieve the FAD) when leaving the fishing zone (P).
- Consider limiting annual buoy purchases like IOTC does. This reduces deployments and incentivizes avoiding abandoning FADs. It also incentivizes FAD sharing. On the negative side, this could also incentivize dFAD stealing and deploying dFADs without buoys.

- Consider science-based spatio-temporal management of FAD activities: Avoid deployment areas with high risk of stranding in sensitive areas (Imzilen et al., 2021), identification of dFAD retrieval passages where many dFADs drift at a particular space/time scale, etc.

Regarding the steps above, the workshop noted that rewards (R) tend to be easier to implement and get compliance with than are penalties (P). The workshop also thought that it may be useful to distinguish between the economic/active life of the buoy/dFAD (i.e., the duration of the dFAD/buoy in the water which is tracked and used for fishing) and the dFAD lifetime (i.e., the lifetime of the FAD in the water outside the fishing ground and for which the buoy is not operational). It was noted that the overall lifetime can be as long as 5 years (10 years in exceptional cases) while, based on skipper experience, the economic/active life is around 6-9 months.

Finally, the workshop briefly discussed dFAD buy-back programs but decided they would not likely work because the economic/active life of dFADs is short.

4.2 Centralized Networks and Registers: A Range of Options

As mentioned earlier, dFADs are comprised of three assets: The dFAD itself, the buoy and the information the buoy provides, with the latter being the most valuable one because it informs the fishing strategy. The practice of deploying many dFADs incentivizes broadscale (and likely redundant) deployment of FADs to capture such information over large fishing regions. Mechanisms that decouple the relationship between the quantum of information and the number of dFADs by sharing information among fishers would enable a reduction in FAD numbers in a way that minimizes the economic impact on the fleets while at the same time lowering unit production costs. Here we provide a range of examples reflecting a possible continuum in the degree of information sharing.

The examples below range from simple to very sophisticated. Compliance and enforcement are important to all of them.

4.2.1 Centralized RFMO Registers for Monitoring

Centralized tRFMO FAD registers can be used for monitoring to support science and compliance aspects. They can also be an initial step before a limited entry program or the more complex networks in Sections 4.2.3 and 4.2.4.

Such a centralized system would have no requirement for fishing-enabling information from the register to be shared with other fleets. In other words, it would not be used for selling dFADs or dFAD information. Unless accompanied with new regulations further reducing existing limits, it would have no direct immediate impact on dFAD at sea and no direct impact on increased dFAD retrieval. But it could help improve monitoring and bring more order into the system, in a way analogous to tRFMO vessel and other registers. FADs are comparable to vessels as another piece of physical capital that impacts fishing mortality and should similarly be registered.

A centralized register may or may not be very effective for compliance and to support science, depending on completeness and accuracy of reporting and the associated requirement for data submission/reporting. It will likely work better as a census of dFADs. Also, it would be the starting point for other networks and registers, such as those described below. In addition, it could be used to demonstrate the potential benefits for sharing information on dFAD positions and nearby vessels that could access that information.

4.2.2 Voluntary Multi-Fleet FAD Networks

As mentioned earlier, vessels within some companies are already sharing and centrally managing the company vessel's dFADs. In some cases, dFADs are also transferred/sold to other companies (this is said to happen in the Pacific Ocean when dFADs drift out of the IATTC area into the WCPFC area). DFAD sharing reduces operational costs (i.e., investment in dFAD construction, deployment and, likely, fuel consumption to move to a productive dFAD), while maintaining fishing opportunities.

The idea here is to promote this practice for multiple companies to share dFADs, for example within a fleet association, a Fisheries Improvement Project (FIP), or an MSC-certified fishery. Such a network would not be comprehensive covering an entire tRFMO area. It could be industry-led or NGO-led and would be voluntary.

There would be multiple ways to implement such a network. For example, participants could have access to dFAD information (position, echosounder biomass estimates) within a radius around their vessels. Alternatively, a control center could assign dFADs to individual vessels following a pre-agreed algorithm.

The network should be tied to rewards and/or penalties that incentivize lower dFAD impacts. For example, there could be market rewards if participating vessels agree to actions such as a certain level of dFAD retrieval and/or use of biodegradable dFADs only, a lower number of dFADs than allowed by the tRFMO, no buoy deactivation, etc. There could be sanctions for the players that do not abide by the rules. These sanctions could be as simple as not getting the market rewards or could range up to receiving more days at sea in effort-regulated fisheries.

The network is likely to work in terms of limiting dFADs in the ocean favored by market or other incentives. There would probably also need to be a change in mentality because different companies may have been competitors for years and old habits are hard to change. However, it could work if it is seen as beneficial to participating companies in terms of economic efficiency and market rewards and, like with option 4.2.1, is a solid starting point for other networks and registers that could ultimately limit dFADs.

4.2.3 Mixed Managed Comprehensive dFAD Network

This would be a more comprehensive regional network. Each vessel or company would deploy a number of dFADs (a smaller number than current limits) that it would continue to monitor. Information from all the dFADs deployed by all vessels would go to a centralized system (tRFMO or third-party run) that would continue to monitor all of them. Vessels would then plan their trips driven by their own dFAD network but could also pay a fee to access information on other´s dFADs available in the central system (for example, those that are in the vicinity or in their route, but not at a visible distance). Other vessels could just pay to access others' dFADs without deploying any.

A variation on the concept would be to make the positions of dFADs available for a given fee, and the echosounder readings under particular dFADs not available or available for a higher fee.

It would be less expensive, collectively, to deploy the dFADs in such a network. In effect, dFADs would become a public good rather than open-access and the overall number of dFADs would be lower than in current practice and presumably without a loss in catch and with greater efficiency. Likely dFAD loss will be reduced and there should be greater opportunities for dFAD retrieval as well.

But the system would still present difficulties such as with compliance and enforcement of vessels not setting opportunistically on dFADs they encounter (although technology such as high resolution dFAD tracks, electronic monitoring and VMS could be used to improve these). As the dFAD network becomes a public good, care must be taken to ensure against free riders.

4.2.4 Fully Managed Comprehensive FAD Network

In this type of network, a fully centralized system (tRFMO or third party-run) would control deploying all dFADs, maintaining and retrieving them and selling dFAD information (position and biomass) to vessels. Vessels would not be allowed to deploy or track their own dFADs. In this network, dFADs would become a regulated common property, replacing open access. As a comparison, controlling the deployment (e.g., number, location and design) and maintenance of FADs is done by governments in some aFAD fisheries.

The system should reduce the overall number of dFADs and costs due to network effects without a loss in catch. But the centralized system would be expensive to operate, especially with an important initial investment, because it would require contracting with non-fishing vessels to deploy and maintain the dFADs. A combination of philanthropic support, investment from vessel and processing companies and investment from flag states could be used to start up the network and afterwards the system could become self-supported from fees.

There could be different mechanisms for the central dFAD manager to sell information such as: auction; subscription fees for different information packages (i.e., position and/or biomass); allocating information about some of dFAD position and biomass to vessels to address equity concerns and auction the rest; etc. When implementing the system, careful consideration needs to be given to logistical, safety and fairness concerns. For the integrity of the system, it would also be important to maintain trust between the parties.

This type of network would likely result in a number of benefits such as better information, greater efficiency, effective compliance, scientific data support, fewer dFADs and increased FAD retrieval. In terms of difficulties, this type of network would likely be hard to accept by the current fishing culture. It would also require a big upfront investment and the logistics of the transition from the status quo would be complex, including allocation and other practical and logistical issues, perhaps requiring as an intermediate step implementation of a network like the ones described earlier.

5. Conclusions

With current fishing practices and RFMO regulations, it is difficult to effectively limit the number of FADs in the ocean. This report provides a number of recommendations, primarily based on economic theory, for additional or alternative approaches that could be taken to limit FADs, particularly dFADs, in ways that would be efficient while minimizing losses to the fishing fleets. These include moving to fully non-entangling biodegradable dFADs and incentivizing activities such as dFAD retrieval, lowering the numbers of dFADs deployed or monitored, and sharing dFAD information.

Examples are provided of different types of networks and registers that could be set up for sharing information, ranging from informal and voluntary, to fully centralized dFAD networks. For the more sophisticated networks, the benefit needed to provide the incentives/financing to implement such a system is the savings resulting from reducing the overall number of dFADs (and therefore dFAD and buoy purchases and transmission rates) without changing the economic efficiency of the fleets. FAD deployments and retrievals will be fewer, but they will have a cost. FAD recovery itself has no cost savings and is the expensive part to do, due to fuel and crew costs and non-fishing time.

Some of these ideas may seem ambitious given the current FAD fishing culture, but it may be useful to keep them on the horizon as something that can be worked towards in a progressive fashion. Undoubtedly, these concepts could be refined further.

6. Recommendations

- RFMOs should require multiple key high-resolution datasets (e.g., satellite-linked echosounder buoys, observer information, logbooks and VMS information) which, if cross-referenced to each other, would improve both FAD-related science-advice and monitoring and compliance of activities.
- Transition towards fully non-entangling biodegradable dFADs which will mitigate several negative ecosystem impacts at once and will facilitate the implementation of other options.
- RFMOs should make stepwise changes, developing gradual, simple, enforceable, inexpensive rules as a first step and then improve. Such an adaptive and incremental approach allows learning and reduces costs due to risk and uncertainty.
- Consider rewards and penalties that will incentivize lower dFAD deployments and higher dFAD retrieval. These include:
  - Penalty (P)-reward (R) tradeoffs between dFAD numbers and dFAD sets.
  - Deposit/Return-like systems where the limit on dFADs for a vessel one year is somehow related to the number of dFADs retrieved in the previous year (P/R).
  - Using penalties for stranded dFADs for a retrieval "bounty" (P/R).
  - Require dFADs/buoys to be transferred (to another fleet or to an entity like an NGO that will then assume responsibility, use and/or retrieve the FAD) when leaving the fishing zone (P).
  - Limit annual buoy purchases, which reduces deployments and incentivizes avoiding abandoning FADs (P). It also incentivizes FAD sharing.
- RFMOs should create centralized FAD registers for monitoring to support science and monitoring. Such registers will also aid in the implementation of more comprehensive networks.
- Understanding the value that the information provided by dFAD buoys must inform fishing strategies, consider a range of network types that could be set up for sharing information and ensure fewer dFADs at sea through efficiency. Examples include:
  - Voluntary multi-fleet dFAD networks where all FADs in the participating companies are managed centrally.
  - Mixed managed comprehensive dFAD networks where dFADs become a public good rather than open access because information is available to all vessels: The vessel's controlled dFADs as current practice, and information from other vessels dFADs for a fee.
  - Fully managed comprehensive FAD network where dFADs would become a regulated common property, replacing open access. FAD deployment, maintenance, monitoring and selling of information would be done by a central body.

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