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ORIGINAL RESEARCH ARTICLE

Priority host plants of the Queensland fruit fly, *Bactrocera tryoni* (Froggatt), based on the host reproduction number for tephritid management, surveillance and trade

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Abstract

The Host Reproduction Number (HRN) is a measure of the number of adult fruit flies that can emerge from one kilogram of fruit. HRN is a useful tool in surveillance, management and trade. I reviewed the literature for Queensland fruit fly (Qfly) and found data on 297 hosts. There were 81 Qfly hosts with HRN data and 216 Qfly hosts with no HRN data. The HRN will help to inform and triage hosts for target surveillance and management programs. Additionally, HRN will inform disinfestation activities pertaining to incursion response management, risk mitigation and trade options. There is a need for scientists to report HRN in a consistent manner so that Qfly management programs and trade protocols might be optimised.

Keywords Market access · Standard · Protocol · Treatment · Status

Introduction

Many countries rely on trade and tourism for their economies. However, increasing international trade, including of fruit and vegetables, increases the chances of inadvertent introduction of exotic pests such as tephritids (Bebber et al. 2014; Early et al. 2016; Robinson and McNeill 2022). Additionally, tourists using air travel carry host fruit, potentially infested with tephritids (Cantrell et al. 2002; Putulan et al. 2004). Similarly, land-based tourists in vehicles are known to carry fruit, some of which is infested with fruit flies (Dominiak et al. 2000; Cantrell et al. 2002, Dominiak and Coombes 2009). After the initial long-distance jump assisted by trade or travellers, local dispersal results in an incursion, establishment and dispersal into a new environment (Meats et al. 2003; Sadler et al. 2011; Dominiak and Fanson 2020).

Tephritid fruit flies are one of the most important invasive and destructive crop pests, causing fruit degradation to the point of inedibility and loss of trade (Cantrell et al. 2002). Detections of exotic tephritids trigger regulatory response to eradicate or contain the incursion (Drew 1997; Fay et al. 1997; Ormsby 2021). Importing countries impose stringent quarantine restrictions to prevent exotic tephritid entry. Fortunately, many endemic and exotic male tephritids are easily monitored by male-lure traps (Suckling et al. 2016). Queensland fruit fly (*Bactrocera tryoni* Froggatt) (Qfly) is regarded as a major threat to exports from Australia. Currently, Qfly is restricted to eastern Australia, New Caledonia, French Polynesia and Pitcairn Island (Leblanc et al. 2013a; Dominiak and Mapson 2017).

The actual risk posed by Qfly is largely based on a particular host plant. Different hosts are known to have different capabilities to support the tephritid life cycle from egg lay to emerged adults. This capacity is measured by the number of adults that emerge from one kilogram of fruit (Cowley et al. 1992) and this metric was termed the Host Reproduction Number (HRN) (Dominiak 2022. The HRN can range from 0 to > 1000 and Follett et al. (2021) placed these HRN into six major categories, based on the log of HRN. These categories were termed the Host Suitability Index (HSI). Many papers provide lists of Qfly hosts but provide little guidance on HRN or HSI (e.g. Hancock et al. (2000). Recently, the HRN and HSI for hosts of Mediterranean fruit fly (*Ceratitis*

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capitata Wiedemann) was reviewed but there was no data on hosts with no HRN (Dominiak and Taylor-Hukins 2022). Here, I reviewed the Qfly literature and found HRN data on 81 hosts and I revised the list of 216 hosts without HRN data.

Methods and results

I followed the methodology described by Dominiak (2022) and Dominiak and Taylor-Hukins (2022). In essence, I used Google Scholar as a search engine because it yields more results than other databases (Pozsgai et al. 2021). The main research term used was "*Bactrocera tryoni*". I added additional terms such as "host" or "suitability" or "susceptibility" or "fruit" and similar terms in successive searches. The search results were examined and references chosen if they provided useful data for HRN. Usually, useful references were contained in the first four pages of each search. I changed the third search word based on the results in earlier searches.

In the formulation of Table 1, each reference for data of each host was examined regarding the host status or reproductive capacity to support adult fruit flies. I used field infestation results where possible to standardize an individual host HRN. Unfortunately, not all papers reported the information required (e.g. Bateman et al. 1966). Some papers reported infestations per fruit and provided insufficient information to calculate the HRN metric. Other papers reported infestation rates in graphs or figures and interpretation was too difficult to obtain accurate figures. Other papers reported infestations of larvae or pupae per kg and this information is not reported here. Different papers report a range of HRN figures. In plant biosecurity, the worst-case scenario is always assumed to be the case. Therefore, I did not include any references that reported a HRN lower than the eventual highest HRN in Table 1. Within Table 1, the HRN is followed by the HSI proposed by Follett et al. (2021). The reasons for different HRN in different hosts was reviewed in references such as Lloyd et al. (2013) and Follett et al. (2021) and will not be reviewed in detail further here.

Many references such as Drew (1989), Hancock et al. (2000), Leblanc et al. (2012), Leblanc (2022), Global Invasive Species Database (2022) and CAB International (2023) provided long lists of hosts without HRN. For completeness, these hosts included: *Acmena graveolens*, *Acmena hemilampra*, *Acmena resa*, *Acmenospermum claviflorum*, *Acronychia acidula*, *Acronychia laevis*, *Acronychia vestita*, *Acronychia* sp. aff. *laevis, Actinidia deliciosa*, Aegle *marmelos*, *Aglaia sapindina*, *Alyxia ruscifolia*, *Amorphospermum antilogum*, *Annona atemoya*, *Annona cherimola*, *Annona glabra, Artocarpus odoratissma*, *Averrhoa bilimbi*, *Barringtonia asiatica*, *Barringtonia calyptrata*, *Barringtonia edulis*, *Beilschmiedia obtusifolo*, *Blighia sapida*, *Bouea macrophylla*, *Calophyllum inophyllum*, *Cananga odorata*, *Canarium vulgare*, *Capparis lucidia*, *Capparis mitchelii*, *Capparis nobilis*, *Capsicum frutescans*, *Castanospora alphandii*, *Carallia brachiata*, *Carissa ovata*, *Cascabela thevetia*, *Casimiroa tetrameria*, *Cassine australis*, *Castanospermum australe*, *Cissus antarctica*, *Cissus* sp., *Citrus aurantium*, *Citrus grandis, Citrus jambhiri*, *Citrus limetta*, *Citrus medica*, *Clausena lansium*, *Clivia miniata*, *Coffea arabica*, *Coffea* sp., *Cryptocarya erythroxylon*, *Cucumis* sp., *Cucurbita moschata*, *Cyphomandra betacea*, *Davidsonia pruriens*, *Dimocarpus longan*, *Diospyros australis*, *Diospyros blancoi*, *Diospyros digyna*, *Diospyros ebenaster*, *Diospyros mespilformis*, *Diospyros virginiana*, *Diplocyclos palmatus*, *Dovyalis caffra*, *Drypetes lasiogyna* var. *australasica*, *Durio zibethinus*, *Elaeocarpus angustifolius*, *Elaeocarpus bancroftii*, *Endiandra compressa*, *Endiandra cowleyana, Endiandra discolor*, *Endiandra longipedicellata*, *Endiandra microneura, Endiandra sankeyana*, *Endiandra wolfei*, *Eremocitrus glauca*, *Eugenia brasiliensis*, *Eugenia dombeyi, Eugenia reineardtiana*, *Eugenia uniflora*, *Euphoria longan*, *Faghraea cambagei*, *Ficus benjamina*, *Ficus leptoclada*, *Ficus macrophylla*, *Ficus pancheriana*, *Ficus racemosa*, *Ficus* sp., *Flacourtia inermis*, *Flacourtia jangomas*, *Flacourtia rukam*, *Fortunella crassifolia*, *Fortunella japonica*, *Fortunella x crassifolia*, *Fragaria ananassa*, *Ganophyllum falcatum*, *Garcinia dulcis*, *Garcinia mangostana*, *Garcina warrenii*, *Glochidion ferdinandii*, *Glochidion harveyanum*, *Glycosmis trifoliata*, *Grewia asiatica*, *Hernandia cordigera*, *Lycium barbarum*, *Maclura cochinchinensis*, *Malgighia emarginata, Malus sylvestris*, *Manikara zapota*, *Melastonia affine*, *Mimusops elengi*, *Momordica charantia*, *Morus alba, Morus nigra*, *Murraya exotica*, *Musa acuminata, Myrciaria cauliflora*, *Nauclea orientalis*, *Nerium oleander*, *Niemeyera chartacea*, *Niemeyera prunifera*, *Normanbya normanbyi*, *Notelaea longifolia*, *Ochrosia elliptica*, *Ochrosia moorei*, *Opuntia ficus-indica*, *Owenia venosa*, *Passiflora aurantia*, *Passiflora foetida*, *Passiflora suberosa*, *Passiflora subpeltata*, *Phaleria clerodendron*, *Phyllanthus acidus*, *Physalis peruviana*, *Planchonella australis*, *Planchonella macrocarpa*, *Planchonella obovoidea*, *Planchonella pohlmaniana*, *Planchonella sphaerocarpa*, *Planchonia careya*, *Pleiogynium timorense*, *Polyalthia nitidissima*, *Polyalthina* sp., *Pourouma cecropiaefolia*, *Pouteria campechiana*, *Pouteria pohlmaniana* var. *pohlmaniana*, *Pouteria sapota*, *Premna serratifolia*, *Prunus cerasifera*, *Prunus salicina*, *Psidium littorale*, *Psidium guineense*, *Prunus cerasifera*, *Rauwenhoffia leichardtii*, *Rhamnella vitiensis*, *Rhodamnia sessiliflora*, *Rhipogonum papuanum*, *Rollinia deliciosa*, *Rollinia mucosa*,

Table 1 Host Reproduction Number for Hosts of Queensland fruit fly. Numbers higher than ten were rounded up. HRN are followed with the host suitability index (in brackets), Non-Host (NH), Poor (P), Moderately Good (MG), Good (G), and Very Good (VG) from Follett et al. (2021)

Hosts	Tephritid range		
	Endemic	Introduced	
	Queensland[A]	New South Wales[B]	Pacific Islands[C]
Acca sellowiana - Feijoa		46 (G)	
Anacardium occidentale - Cashew			11 (G)
Annona muricata - Soursop			9.6 (MG)
Annona reticulata - Custard apple		26 (G)	60 (G)
Annona squamosa - Sugar-apple			13 (G)
Artocarpus altilis - Breadfruit			17 (G)
Artocarpus heterophyllus - Jackfruit			0.03 (P)
Averrhoa carambola - Carambola, starfruit	4 (MG)		21 (G)
Capsicum annuum - Capsicum		24 (G)	19 (G)
Carica papaya - Papaya			17 (G)
Casimiroa edulis - White sapote			9.4 (MG)
Chrysophyllum caimito - Star-apple			38 (G)
Citrus aurantiifolia - Lime			14 (G)
Citrus australasica - Finger lime		0[J] (NH)	
Citrus japonica - Kumquat	25 (G)	234 (VG)	30 (G)
Citrus latifolia - Tahiti lime			6.2 (MG)
Citrus limon - Lemon Lisbon	5 (MG)	3.3 (MG)	
Citrus limon - Lemon Eureka (yellow)	2 (MG)		
Citrus limon - Lemon Eureka (green)	0 (NH)		
Citrus maxima - Pomelo			12 (G)
Citrus x paradisi - Grapefruit	17 (G)	4.7 (MG)	18 (G)
Citrus reticulata - Mandarin		43 (G)	
Citrus reticulata - Mandarin Ellendale	20 (G)		
Citrus reticulata - Mandarin Imperial	52 (G)		
Citrus reticulata - Mandarin Murcott	83 (G)		
Citrus reticulata - Tangerine	83 (G)		89 (G)
Citrus sinensis - Sweet Orange		142 (VG)	4.4 (MG)
Citrus sinensis - Orange Navel	26 (G)		
Citrus sinensis - Orange Valencia	8 (MG)		
Cucurbita pepo - squash, zucchini, pumpkin			1.6 (MG)
Cydonia oblonga - Quince		63 (G)	
Diospyos kaki - Japanese Persimmon	5 (MG)		13 (G)
Eribotrya japonica - Loquat		324 (VG)	125 (VG)
Ficus carica - Fig edible	10 (G)		
Fragaria vesca - Strawberry			153 (GV)
Inocarpus fagifer - Tahiti chestnut			131[K] (G)V
Juglans regia - Walnut		14 (G)	
Litchi chinensis - Lychee			8.3 (MG)
Mangifera indica - Mango		4.2 (MG)	64[K] (G)
Malpighia glabra - Acerola			135 (VG)
Malus domestica - Apple	54 (G)	12 (G)	
Morinda citrifolia - Noni			1.8 (MG)
Morus alba - White mulberry			281 (VG)
Musa x paradisiaca - Banana			42 (G)
Musa troglodytarum - Fe'i banana			4.6 (MG)
Nephelium lappaceum - Rambutan			60 (G)
Olea europaea - Olives		33[E] (G)	
Opuntia sp. - Prickly pear		6.1 (MG)	
Passiflora edulis - Purple passionfruit			6.7 (MG)
Passiflora laurifolia - Yellow passionfruit			27 (G)
Passiflora quadrangularis - Giant passionfruit			3.8 (MG)

Table 1 (continued)

Hosts	Tephritid range		
	Endemic	Introduced	
	Queensland[A]	New South Wales[B]	Pacific Islands[C]
Persea americana - Avocado	22 (G)		129 (VG)
Phoenix dactylifera - Date palm	34 (G)		
Pometia pinnata - Pacific lychee			106 (GV)
Pouteria caimito - Abiu			18 (G)
Prunus armeniaca - Apricot		63 (G)	
Prunus avium - Cherry		8.9 (MG)	
Prunus domestica - Plum			17 (G)
Prunus persica - Peach		179 (VG)	43 (G)
Prunus persica var. *nucipersica* - Nectarine		176 (VG)	
Prunus simonii - Nectarine			12 (G)
Psidium acutangulum – Crown guava			22 (G)
Psidium cattleianum - Strawberry guava			122 (VG)
Psidium guajava – Common guava		92 (G)	4,065[G] (VG)
Punica granatum - Pomegranate		4.1 (MG)	17 (G)
Pyrus communis - Pear		56 (G)	
Pyrus pyrifolia - Nashi pear		73 (G)	
Rosa sp.	354[H] (VG)	40[D] (G)	
Solanum lycopersicum - Tomato		< 1 (P)	44 (G)
Solanum melongena - Eggplant			2.3 (MG)
Spondias dulcis - Jew plum			4.1 (MG)
Syzygium cumini - Java plum, Jambolan			4.8 (MG)
Syzygium jambos - Rose-apple			119 (VG)
Syzygium malaccenense - Malay-apple			32 (G)
Syzygium uniflora - Surinam cherry			222 (VG)
Terminalia catappa - Tropical almond			375[G] (VG)
Thevetia peruviana - Yellow Oleander	43 (G)		
Vaccinium sp. - blueberry		869[F] (VG)	
Vitis vinifera - Grapes		53 (G)	
Ximenia americana - Yellow plum			4.4 (MG)
Ziziphus mauritiana - Indian jujube			109 (VG)

[A] Based on Lloyd et al. (2013), unless indicated otherwise

[B] Based on Dominiak et al. (2020), unless indicated otherwise

[C] Based on Leblanc et al. (2013a), unless indicated otherwise

[D] Dominiak et al. (2018)

[E] Dominiak et al. (2019)

[F] Campbell and Jessup (2007)

[G] Vargas et al. (2007)

[H] May (2022)

[J] Jessup et al. (2006)

[K] Leblanc et al. (2013b)

Rollinia pulchrinervis, *Rubus fruticosus*, *Rubus loganobaccus*, *Rubus ursinus*, *Rubus ursinus* var. *loganobaccus*, *Salacia chinensis*, *Sandoricum indicum*, *Sandoricum koetjape*, *Santalum lanceolatum*, *Scaevola taccada*, *Schizomeria ovata*, *Seavola taccada*, *Semecarpus australiensis*, *Siphonodon australis*, *Solanum laciniatum, Solanum mauritianum*, *Solanum muricatum*, *Solanum seaforthianum*, *Solanum torvum*, *Spondias cytherea, Spondias mombin*, *Spondias purpurea*, *Synsepalum dulcificum*, *Syzygium alliiligneum*, *Syzygium angophoroides*, *Syzygium aqueum*, *Syzygium australe*, *Syzygium canicortex*, *Syzygium cormiflorum*, *Syzygium corynanthium*, *Syzygium erthrocalyx*, *Syzygium fibrosum*, *Syzygium forte*, *Syzygium kuranda*, *Syzygium luehmannii*, *Syzygium megacarpa*, *Syzygium paniculatum, Syzygium puberulum*, *Syzygium rubrimolle*, *Syzygium samarangense*, *Syzygium smithii*, Syzygium *suborbiculare*, *Syzygium tierneyanum*, *Syzygium xerampelimum*, *Terminalia arenicola*, *Terminalia aridicola*, *Terminalia ferdinandiana*, *Terminalia melanocarpa*, *Terminalia muelleri*, *Terminalia platyphylla*, *Terminalia seriocarpa*, *Terminalia subacroptera*, *Trichosanthes anguina*, *Trichosanthes cucumerina* var. *anguinea*, *Vitis labrusca* and *Ziziphus jujuba.* Additionally, *Gossypium hirsutum* and *Maclura pomifera* were added by Khan et al. (2012) and Reynolds et al. (2015) respectively.

Discussion

Of the reported 297 hosts, the 81 hosts with a recorded HRN are provided in Table 1. However, there are 216 (72.7%) other known hosts with little or no recorded HRN. Previously in an Australian review, Hancock et al. (2000) identified 243 hosts; 58 hosts now have HRN. There were 40 “major hosts” identified by Hancock et al. (2000) but I could find HRN data on only 21 of these hosts. Within the data available, the Hancock’s “major host” had HRN that ranged from 6.7 to 4,065. Perhaps part of the “major host” categorisation was based on the proportion of hosts infested. For example, in Western Australia, they examined 62 hosts but found Qfly in only eight hosts with loquat most commonly infested (44 trees) compared to eight fig plants, five apricots and one guava (Sproul and Froudist 1992). The HRN for these hosts are 324 (loquat), 10 (fig), 63 (apricot) and 4,065 (guava) respectively so HRN alone does not explain the rate of infestation. Lloyd et al. (2010) reported a wide range of the proportion of hosts infested. I suspect that the classification of “major host” was linked to the proportion of host infested, rather than HRN.

There are some inconsistencies with HRN metrics in Table 1. Kumquats in southern New South Wales (NSW) were recorded with HRN = 234 but kumquats had a HRN of 25 and 30 in Queensland and the Pacific Islands respectively. In Queensland, only two of 24 samples were infested (Lloyd et al. 2010). It seems that kumquats are a more important Qfly host in southern NSW. Similarly, the HRN for sweet oranges ranged from 142 in NSW to < 30 in the other two locations. In Queensland, 26 of 227 samples were infested (Lloyd et al. 2010). Again, oranges seem to have a different risk profile in southern Australian climates. The HRN for avocadoes ranged from 129 (Pacific Islands) to 22 (Queensland). Roses ranged from 354 (Queensland) to 40 (NSW). Guava has a high HRN for many fruit flies (Dominiak 2021) but the HRN for guava ranged from 92 (NSW) to 4,065 (Pacific Islands). However, the high 4,065 was the highest HRN in a nine-year program with a HRN < 100 in seven of the other eight years. Vargas et al. (2007) suggested that guava’s lower HRN may be due to competition from *B. dorsalis* (Hendel) or the introduction of parasites or both.

Variations in my comparison could be due to many factors. Dominiak et al. (2020) reported the maximum HRN while Lloyd et al. (2013) reported mean HRN and hence I may have intrinsically underestimated the Queensland HRN in this comparison. NSW is at the southernmost range of Qfly compared to Queensland and the Pacific Islands and Qfly may interact with hosts differently. Therefore, this current HRN ranking should be regarded as the initial step in understanding the fly-host relationship. Some reported high HRNs may not apply to all circumstances. For instance, altitude seems to play a role in Africa (see review in Dominiak 2022). There were greater infestations of *Anastrepha* sp. in the dry season while other species were more prevalent in the wet season (Birke 2023). Fruit infestation by *Bactrocera* spp. was positively correlated to fruit weight and vitamin C but negatively correlated with fruit firmness, acidity and total phenolic content (Aarti et al. 2023). Larger fruit were more prone to co-infestation than smaller fruit (Birke 2023). Higher sugar content and lower levels of phenols and tannins were highly correlated to infestation and emergence (Orono et al. 2019). Therefore, variations in HRN may be argued down from the worst-case scenario based on local circumstances.

The current knowledge of Qfly HRN is valuable. There was additional data available however not in the HRN format or in a way that HRN could be calculated. Therefore, based on the list of 216 hosts with no recorded HRN, there is considerable research yet to be done to fully understand how hosts influence management at a grower level. Particularly, the role of native hosts growing near commercial production sites remains poorly understood.

HRN has three main work areas in fruit flies. Firstly, the use of HRN can inform and triage surveillance targets for early detection or pest population monitoring. Early detection will increase the chance of corrective action before establishment occurs in fruit fly free zones and Pest Free Production Sites (Fay et al. 1997; Cantrell et al. 2002; Dominiak and Mapson 2017; Leblanc et al. 2013b). Secondly, in local or regional management, fruit fly control measures are more likely to be successful in shorter times if all the risk hosts in the area are known. For example, programs are less likely to be effective if regulatory staff walk past and ignore the roses (HRN = 354) in the front garden to treat only the peach (HRN = 179) or orange (HRN = 142) in the backyard (Dominiak et al. 2020). Regarding fruit carriage by land and air travellers and possible incursions, low HRN fruit are less likely to result in establishment compared to high HRN fruit (for the same weight of fruit carried) (Meats et al. 2003; Dominiak and Fanson 2023). This HRN knowledge could be used to better target the education of travellers (Dominiak and Coombes 2009).

Finally, market access is reliant of the demonstration of minimum risk to the importing country or state. Some commercial hosts have no recorded HRN and this may limit market access opportunities using the *Systems Approach* (Jang 2006; Dominiak 2019; Van Klinken et al. 2020). A *Systems Approach* integrates two or more independent phytosanitary measures to cumulatively provide an appropriate biosecurity confidence (Follett and Neven 2006; Sequeira and Griffin 2014). The Systems Approach offers a more robust system to provide a more nuanced approach of using a system or combination of risk mitigation measures that reach a level of efficacy previously provided by an end point treatment but are not vulnerable to a possible failure of that end-point treatment (Quinland et al. 2020). The concept of poor host status, along with other conditions, was used as part of a systems approach to export 'Sharwil' avocadoes from Hawaii to continental United States (Follett and Vargas 2010). Recently, Follett et al. (2022) proposed a systems approach for 'Malama' avocadoes using poor host status, low pest prevalence and limited harvest period for export from Hawaii to mainland USA.

For trade, a probit 9 or 8.7 treatment response level is required by many importing countries. For many countries, a 99.99% mortality level is acceptable for quarantine treatment efficacy, treating only about 30,000 individuals (Follett and Neven 2006). However, this level of treatment may be overly demanding for poor hosts that are rarely infested or infested at very low levels. In low HRN cases, a less stringent treatment protocol may provide the equivalent level of quarantine security such as probit 9 (Follett and McQuate 2001). A low HRN status may become a particular category for trade, just as a "hard green" status identifies a particular susceptibility to tephritids such as Qfly.

An alternate approach is to use probability to demonstrate that an appropriate level of protection or risk mitigation has been reached, equal to an end-point treatment (Quinlan et al. 2020). A Bayesian network was used to model the Qfly populations to persist or survive in an area-wide management of habitat (van Klinken et al. 2019. Similarly, the scenario tree analysis was used to statistically demonstrate that pest populations had been eradicated or were non-existent (Dominiak et al. 2011; Magarey et al. 2019; Charlton et al. 2022). A similar approach could be used to statistically demonstrate the components of a systems approach can reach a status equivalent to probit 9. HRN would be a useful component to such an analysis. These statistical techniques have been used in pest and landscape (area) analysis but are yet to be demonstrated in a pest and commodity (volume) setting.

Regarding current end-point treatments, hosts with a low HRN (e.g. lemons HRN < 4) may not need to be treated with the same disinfestation protocol as a host such as oranges (HRN = 142) where the biosecurity risk is considerably higher. Should oranges be treated the same as blueberries (HRN = 869)? In a systems approach, low HRN may be combined with winter window of non-breeding in cooler months or in the southern most edge of the Qfly range (Clarke et al. 2022; Follett et al. 2022). This window may be part of the seasonal weight changes in Qfly: Dominiak et al. (2021) reported lower weights in autumn which were possibly linked to longevity rather than dispersal. Perhaps this lower weight also may trigger a non-breeding phase to survive the challenging conditions of winter.

Given the variable nature of HRN reporting, there is a need for a more consistent approach to HRN to optimise surveillance, management and trade. In particular, there is a need for all scientists to report the maximum and seasonal HRN for biosecurity purposes. The collection of HRN data would lead to the opportunity to develop host specific trade protocols for treatment of poor hosts because low HRN hosts inherently provide a lower risk of transporting target fruit fly into new areas (Follett and McQuate 2001).

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Declarations

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