Integrated Control of Water Hyacinth on the Nseleni/Mposa Rivers and Lake Nsezi, Kwa Zulu-Natal, South Africa

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Abstract

Water hyacinth infestations on the Nseleni/Mposa River system were sprayed with a herbicide on an ad hoc basis between 1983 and 1995, with no real results being achieved. During the summer of 1985–86, the first biological control agent, the weevil *Neochetina eichhorniae,* was introduced into the system, and by the end of 1986 beetle activity, estimated by adult feeding scars, was common throughout. During 1995, a formal Integrated Water Hyacinth Control Programme was introduced to form a holistic approach to use the various control options that were available; i.e. chemical, mechanical and biological.

A committee comprising all parties/communities adjacent to the rivers and lake that were affected by the water hyacinth was formed to monitor the new integrated control program. The program consists of four main components, namely: Survey, Plan, Control and Record. The Nseleni River (17.1 km affected), Mposa River (4.9 km affected) and Lake Nsezi (≈ 260 ha) have been divided into eight management units.

By using the integrated control approach, a total of 18.9 km of river has been cleared of water hyacinth between 1995 and the present. The management units that have been cleared of water hyacinth, now require only occasional follow-ups to spray any regrowth with a herbicide or to physically remove it. Recent records indicate that previously recorded 'red data' species of avifauna have returned to the area, namely bitterns (vulnerable and rare), storks (rare) and African finfoot (indeterminate). Oral reports from the local rural communities that rely on fish as a source of food, indicate that their catches have improved—a sure sign that the control of water hyacinth in the system is having a positive ecological impact.

Also of importance is the fact that there is reduced evapotranspiration because of removal of water hyacinth, which in turn makes more water available to the environment, industry and the surrounding communities, both rural and urban. The rural communities have benefited directly, as they are now able to fish and thereby feed their families. As a result of the success of this control program, the entire catchments of the Mposa River (Mbabe and Nyokaneni rivers) have been included in the program.

WATER hyacinth was first recorded in South Africa (Cape Province and Kwa Zulu-Natal) in 1910 (Gopal 1987). It is believed to have been introduced as an ornamental aquatic plant and has since been spread to numerous localities throughout the country by gardeners, aquarium owners and boat enthusiasts (Jacot Guillarmod 1979). The main distribution occurs from low-lying subtropical to high elevations where frost occurs (Cilliers 1991).

Water hyacinth is not the only problematic alien aquatic plant in South Africa, as other aquatic plants such as parrot's feather (*Myriophyllum aquaticum)*, red water fern (*Azolla filiculoides*), water fern (*Salvinia molesta*), water lettuce (*Pistia stratiotes),* the

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reed (*Arundo donax*) and the bullrush (*Thypha capensis*) also occur. Water hyacinth it is believed to be the most problematic. In addition, plants such as the two reeds *Phragmites mauritianus* and *P. australis* have been identified as being plants with future major impact possibilities (C.J. Cilliers, pers. comm.).

Water hyacinth is a declared weed in South Africa and is covered by legislation. This is the *Conservation of Agricultural Resources Act* (Act 43 of 1983) and is administered by the Directorate of Resources Conservation of the National Department of Agriculture. The Act states clearly that this weed must be controlled. The South African Department of Water Affairs and Forestry (DWAF) is mandated to co-ordinate the control of water hyacinth and to execute measures in situations where the weed threatens state water works. In other scenarios it becomes the responsibility of the provincial and local water authorities.

Water hyacinth was first recorded on the Nseleni/Mposa Rivers (28°42'S; 32°02'E) and Lake Nsezi system in 1982 (Ashton 1982) and is believed to have been introduced in approximately 1978 as an ornamental plant. At this stage the water hyacinth infestation had already been recognised as being a problem, covering an area of approximately 1.5 km^2. There were serious concerns that damage would be caused to: (1) the national road bridge over the Nseleni River, and (2) the functioning of the two water treatment facilities on Lake Nsezi.

The Nseleni and Mposa rivers, as well as Lake Nsezi, are used by the surrounding rural communities to supplement their daily food with fish catches. For many, the fish they catch are their main source of dietary protein. Both large-scale sugarcane farms and small-scale subsistence farms also irrigate from the river. Mhlathuze Water Board (the local water authority) pumps water from Lake Nsezi and supplies water for both domestic and industrial use to the greater Richards Bay and Empangeni areas. In addition, extraction points for Richards Bay Minerals (mining) and the rural town of Nseleni are located on the Nseleni River. A sewage plant that serves the rural town of Nseleni is located on the bank of the Mposa River.

The Kwa Zulu-Natal Nature Conservation Service (KZNNCS) at one stage offered boat trips for bird viewing on the Nseleni River. These were abandoned as water hyacinth encroached on the river. Rare species of avifauna, like the African finfoot (*Podica senegalensis*) and other aquatic fauna and flora disappeared from the area, as a result of the increase in the water hyacinth infestation. In addition, the rural communities were not only unable to fish, but also found it impossible to cross the Nseleni River to get to their work places on farms.

Control Efforts

Ad hoc control efforts were practised between the late 1970s and 1994 by various interested and affected parties. By 1982, stretches of the Nseleni and Mposa rivers were covered with water hyacinth (100% coverage) and KZNNCS initiated control of the weed. In 1984, a heavy flood alleviated the problem, as most of the water hyacinth was washed away before an aerial spraying operation could be implemented. Thereafter, little was done to the remaining islands of water hyacinth, because the decreased level of infestation was no longer seen as a threat.

Chemical control was reintroduced in the mid 1980s when the Nseleni River was once again covered by water hyacinth, but there was no management plan and chemical spraying was carried out on an ad hoc basis. It is important to note that eradication/control steps were undertaken only once the water hyacinth became a problem.

In an independent effort, the Plant Protection Research Institute (PPRI) of the Agricultural Research Council imported (via Australia) a weevil, *Neochetina eichhorniae*, releasing 1400 adult insects on the Mposa River in December 1985. By November 1989, most of the water hyacinth had once again washed away as a result of exceptionally heavy floods. However, the biological control agents persisted on the remaining water hyacinth.

To put a monetary value on the economic loss caused by water hyacinth on nearly 22 km of river and 360 ha of lake proved to be extremely difficult, because of the ad hoc control efforts that were implemented. The cost to KZNNCS in just keeping the river open on its 6.3 km of river boundary amounted to R15,000[1] in 1991. When the infestation was at its height by the mid 1990s, it cost R20,000 to clear sections of the river.

Mhlathuze Water Board remains opposed to and concerned about any possible large-scale chemical spraying of water hyacinth and the effect the decaying organic material would have on the odour and taste of the water. In addition, it also feels that water hyacinth partly purifies the water, because of the nutrients it takes up. Large-scale aerial spraying could also have detrimental environmental effects on lake and riparian

[1] R = South African Rand. In March 1991, R3.67 = US$1.

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vegetation such as *Papyrus* spp. and *Barringtonia racemosa,* as well as other indigenous flora. This would be undesirable and ecologically unacceptable. In addition, any uncoordinated large-scale chemical spraying at the wrong time would nullify the effect of the biological control agents, as all sessile stages are killed when plants are sprayed when there is not a peak of adult insects.

In an additional independent effort, PPRI (Pretoria) introduced *Niphograpta albiguttalis* (150 moth larvae) and a mite *Orthogalumna terebrantis* (800 adults) in January 1994, in an attempt to supplement the previously introduced weevil *N. eichhorniae.* At the same time as these biological control agents were released, water hyacinth plants were inspected for weevil damage. Results indicated that the weevil *N. eichhorniae* had spread throughout the system, which was a positive sign.

During 1994, an aerial survey was undertaken in an attempt to record the extent of the water hyacinth infestation in the entire system. The results of the survey indicated the infestation varied between 100% and approximately 40% coverage in different sections of the system.

Integrated Water Hyacinth Control

In March 1995, an Integrated Water Hyacinth Control Committee was formed. This committee met regularly and welcomed other representatives from the community to attend these meetings. It also held 'open days' to show the community the results achieved.

The first objective of the committee was to collate all the work that had previously been carried out on the water hyacinth infestation and to formulate a holistic approach to use the various control options that were available; i.e. chemical, biological and mechanical. In addition, a management plan was formulated, consisting of four main components, namely Survey, Plan, Control and Record, as well as an action plan for when floods occurred.

A map of the system (affected areas: Nseleni River – 17.1 km, Mposa River – 4.9 km and the Nsezi Lake – 268 ha) was drawn up and used to designate eight management units (MUs) of controllable size (Fig. 1). Further to this, each MU was assigned a level of control, i.e. total control or containment, as well as the appropriate method of control, i.e. chemical, biological, mechanical or a combination of control methods.

It was emphasised at the outset that the management plan was a working document and that objectives and control methods would change as work progressed. In addition, the committee emphasised and recognised that total eradication was impossible, because of the long lived seed source. Water hyacinth seed can lie dormant for up to 14 years (Penfound and Earle 1948). It was therefore recorded that total maximum acceptable percentage coverage would be 20%.

Each MU was assigned to an individual, organisation or company. For example, MU 1 was assigned to a sugarcane farmer and KZNNCS, MU 2 to KZNNCS, MUs 3 to 5 to MONDI Forestry and KwaMbonambi Conservancy, MUs 6 and 7 to KZNNCS and MU 8 to the local water authority—the Mhlathuze Water Board (to merely inspect and report on the status of biological control agents).

In March 1995 it was stated that the objective for MUs 1 to 4 would be total control using all methods available, and that containment of the infestation using biological control agents in MUs 5 to 8 would take place. Further to this, various sectors from the community were assigned MUs to control. Awareness campaigns were run at the same time, through lectures, radio talks and articles in the local press. Instead of using labour from the local rural community to remove water hyacinth manually, school children and their elders were successfully prompted to replant and stabilise the banks of the river with suitable indigenous vegetation where they had previously chopped down trees to practise subsistence farming. This was done because of the threat from crocodiles in the river, which killed several children every year. This was unrelated to water hyacinth control.

In an attempt to reduce the spread of water hyacinth seed and to make the chemical control cost effective, permanent cable booms (28 mm steel) were placed across the river at the confluence of the Mposa and Nseleni rivers (MU5), at the southern end of MU2 and at the northern end of MU6. Cables were also installed across the river where MUs 6 and 7 met and where MUs 7 and 8 met. The cables were placed in such a manner that they hung beneath the surface of the water, thereby catching the root system of the water hyacinth. Plastic buoys (donated by the Richards Bay Coal Terminal) were used as flotation on the cables. Note that each permanent cable has a 'weak link' in it. Previous experience showed that during floods, not only was there a vast volume of water, but that the cable anchors (trees) were unable to hold the weight of the water hyacinth that built up on the cables.

In addition to the permanent cables across the river, temporary cables placed across MUs 1, 2 and 6 to allow the water hyacinth to back-up against them, which assisted the chemical control method.

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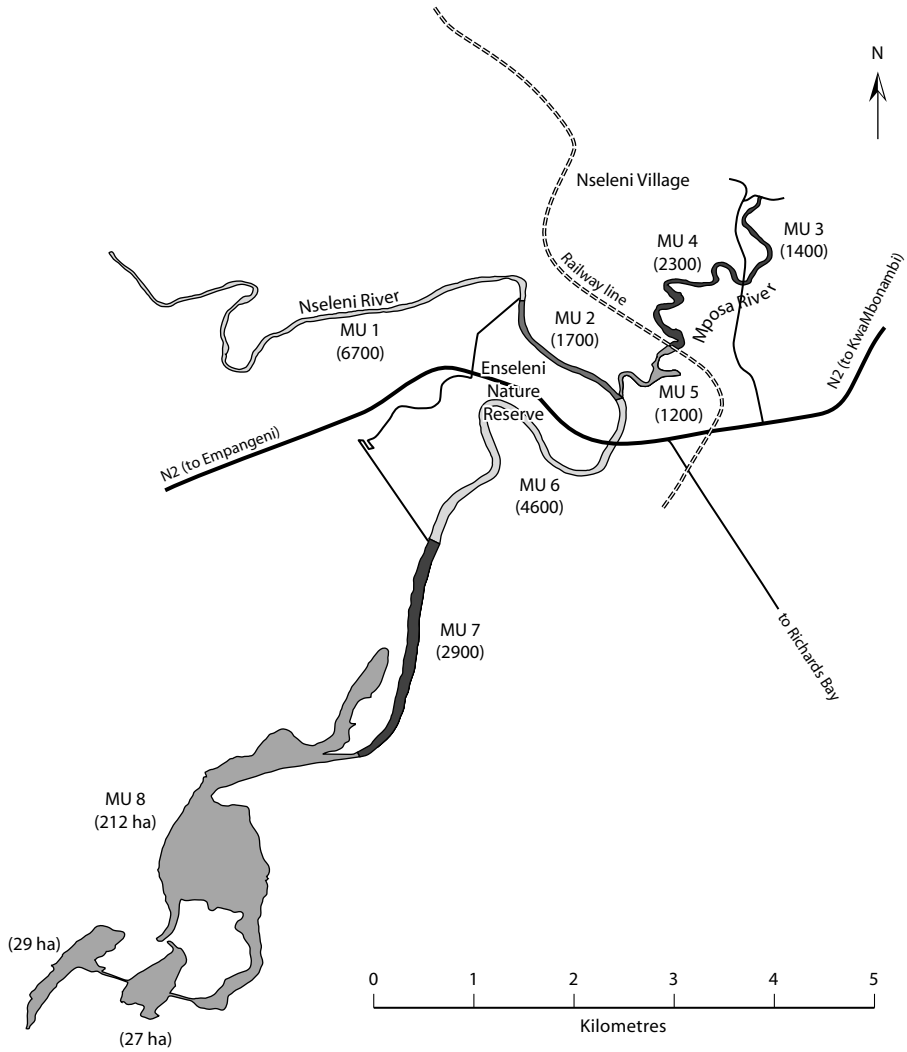

Figure 1. Management units (with length of units in metres) for water hyacinth control on the Nselini/Mposa rivers and Lake Nsezi

Further assistance to the control program occurred when the Nseleni sewerage works on the Mposa River was upgraded, and the effluent quality improved dramatically. Before upgrading, the ammonia (NH_3) was 14.2 ppm and the chemical oxygen demand (COD) 130 ppm. After commissioning, the ammonia dropped to 1.2 ppm and the COD to 53 ppm, a vast improvement. However, it was further recorded that nutrients were entering the system from adjacent sugarcane farms and forestry areas.

During the course of 1995, a total of approximately 2400 litres of glyphosate had been sprayed in MUs 1, 2, 3, 5 and 6 and seven river patrols were carried out to monitor water hyacinth infestations, inspect the effect that spraying and biological control had on water hyacinth and to carry out routine maintenance of the cables

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(total cost R9345.00). As a result of the success levels achieved by the end of 1995, the control committee agreed to adjust the management plan objectives and to elevate MU6 to total control and to retain MUs 7 and 8 as containment MUs (biological control only).

Because the local water authority needs to remove water hyacinth from its inlet screens, it has agreed to remove biological control agents from the water hyacinth and to return them in Lake Nsezi, thereby ensuring that they are maintained in the system.

In March 1996, the first release (50 adults and 100 nymphs) was made of a new biological control agent, the mirid *Eccritotarsus catarinensis*, at the entrance to Lake Nsezi. During June 1996, a further 500 adult *E. catarinensis* were released. It was reported at the June 1996 meeting that no chemical spraying had been done in MUs 1, 2 and 6. Because of the decreased infestation level of water hyacinth, these units had merely been monitored. The status of biological control agents throughout the system was positive, with one or more agents being recorded in the MUs where water hyacinth infestations occurred. In addition, the pathogen *Cercospora piaropi* was found on some plants, and the fungus *Acremonium zonatum* was recorded for the first time.

During October 1996, another weevil species, *Neochetina bruchi*, was obtained from PPRI (Pretoria), as well as additional *E. catarinensis* (10 infested plants), and these were released into the system. In addition, the management plan objectives were again adjusted to reflect the progress being made. The management plan now allowed for total control in MUs 1–7, with only MU8 designated for containment (biological control only). It was also agreed to drop the total allowable coverage percentage from 20% to 10%.

Records indicate that financial expenditure on control of water hyacinth during 1996 fell to R5892.00.

During 1997, glyphosate herbicide continued to be applied to water hyacinth in MU 5 (100% infestation) and MU 7 (infestation increased to 60%), with varying amounts of success. It is important to realise that the islands of water hyacinth are left after the application of chemicals. This is to allow the biological control agents to continue to move within the system.

Entry into the Mposa River (MU 5) from the south became extremely problematic, because not only was there a 100% infestation of water hyacinth, but also indigenous aquatic vegetation had severely encroached on the area. Of note was the invasion of *Echinochloa pyramidalis,* an indigenous perennial plant, which enjoys moist terrestrial or aquatic conditions and uses water hyacinth as a substrate on which to form dense stands. Other possible contributing factors towards the establishment of *E. pyramidalis*, are nutrient enrichment of water and silt-laden watercourses.

During 1997, a distance of approximately 200 m was gained into MU 5, from the southern side. In addition, MU 6 had to receive attention, because the total allowable percentage coverage exceeded 10%. Some 296 litres of glyphosate was used in MUs 5 and 6, with the required result being achieved. The status of biological control agents in MUs 3, 4, 5, 7 and 8 remained positive. A further 300 adult *E. catarinensis* were released on Lake Nsezi during the latter part of 1997.

By September of 1998, a further 238 litres of glyphosate had been applied to MUs 5, 6 and 7. Some 28 hours and 78 labour units, over a period of 25 days, were expended to inspect, carry out cable maintenance and chemically spray the water hyacinth infestations. The results of the water hyacinth infestation inspections indicated a high percentage of biological control agent activity throughout the system. During August 1998 a setback occurred when an area of approximately two hectares of water hyacinth was blown from MU 7 into MU 6, during a period of exceptionally strong southeasterly winds. Fortunately, the cable did not break and a high percentage of water hyacinth remained in MU 7. With the aid of temporary cables the approximately two hectares of water hyacinth that had blown into MU 6 and which had subsequently broken up into smaller pockets, was cordoned off and chemically sprayed.

A major injection to the control program in 1998 was the assistance received from the MONDI forests company, which achieved excellent chemical control results in MU 4 (Mposa River). Between May and October 1998, MONDI spent R2800 per month on chemicals and labour, to open up stretches of the Mposa River from both water hyacinth and invasive indigenous aquatic plants. In addition, KwaMbonambi Conservancy approached various industries in Richards Bay in an effort to get them to become involved in the project. The result of this drive was that R38,000.00 was received (to purchase new spraying equipment and an outboard engine) and MONDI Kraft offered to construct a barge-like boat and a trailer (approximately R50,000) which would be used in spraying. Further to this, KwaMbonambi Conservancy pledged 200 litres of roundup and Richards Bay Minerals pledged R6000 towards the project.

A flood during February 1999 opened up about 1 km of MU 5, and MUs 1, 2, 6 and 7 became 98% free of

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water hyacinth. The infestation in Lake Nsezi had dropped dramatically to approximately 35%. During May 1999, for the first time in many years, members of the control committee were able to proceed from a launch site in MU 2 and travel all the way to the Mhlathuze Water Board extraction point on the south-east bank of Lake Nsezi (MU 8). Biological control agents persisted on the remaining water hyacinth.

As a result of the high success rate achieved with the integrated control on the Nseleni River and a small section of the Mposa River (MU5), it has been decided to expand this project to include the catchment of the Mposa Rivers, namely the Mbabe and Nyokaneni rivers. A management plan is currently being drawn up to focus on 14 management units on these rivers (Fig. 2).

Community Involvement

Community involvement has no doubt been the secret of the success of the integrated control program. Although the control of water hyacinth was initiated by staff from the Enseleni Nature Reserve (KZNNCS), it soon became apparent that additional assistance would be required from the surrounding community, as well as the 'end users' of water, i.e. industry and

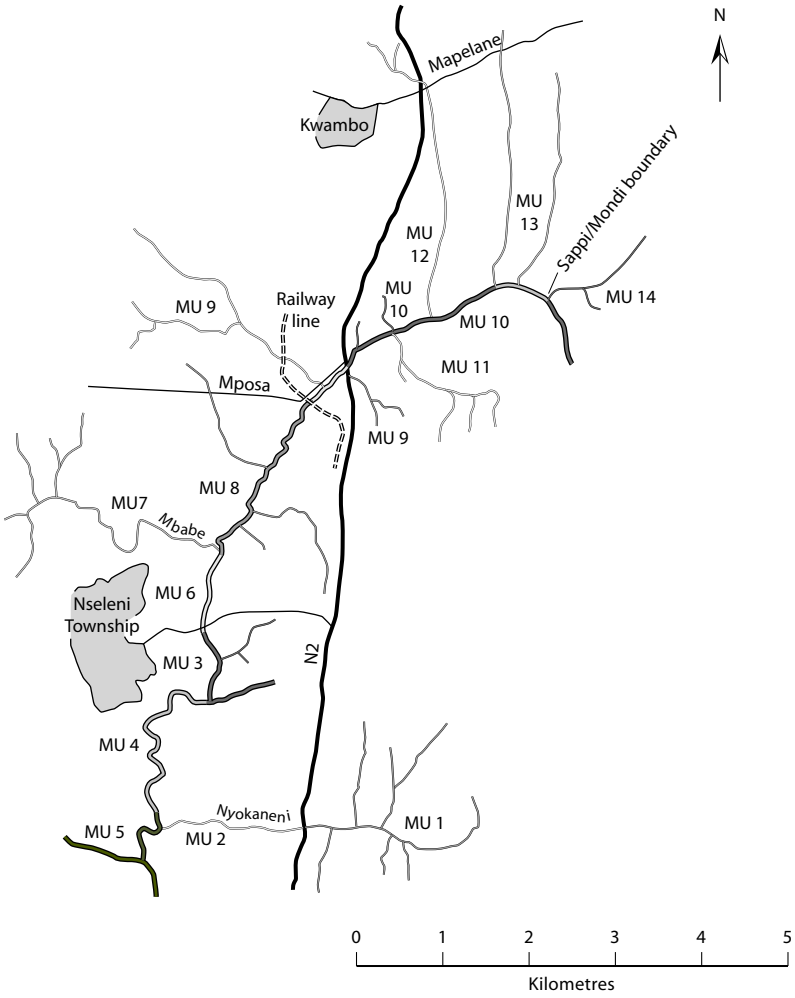

Figure 2. Water hyacinth management units of the Mbabe and Nyokaneni rivers

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urban communities. The surrounding communities became involved in the project because they depend on the water resource directly for their livelihood (fishing and agriculture), or as an extractable resource (for mining, industrial and urban uses).

It is important to note that, although such projects require vast amounts of funding in the initial stages to bring the infestation under control, a level will be reached where only maintenance will be required and therefore a set annual funding requirement must be obtained. However, funding requirements will diminish only if there is enthusiasm, success and a stable authority responsible for the implementation of the project.

Conclusion

By using an integrated control approach, between 1995 and the present, a total of nearly 22 km of river has been cleared of the original infestation of water hyacinth. The sections that have been cleared of water hyacinth now require only occasional follow-up to remove any regrowth. Recent records indicate that previously recorded 'red data' species of avifauna have returned to the waterways. Reports from the rural community, which relies on fish as a source of food, indicate that their catches have improved—a sure sign that the clearance of water hyacinth in the system is producing a positive ecological impact.

The advantages of controlling water hyacinth infestations far outnumber the disadvantages.

Water, as a natural resource, is for many reasons fast becoming a dwindling resource, and therefore demands especial attention.

Because of the success achieved with the integrated control program, the entire Mposa River catchment, i.e. the Mbabe and Nyokaneni rivers, has now been included in the control program.

Uncoordinated efforts to control water hyacinth on the same system by different parties have proven to be a waste of time and money. Once a proper integrated management plan and control is implemented, water hyacinth infestations can be reined in. Nevertheless, prevention is better than cure, and it is of the utmost importance that infestations of water hyacinth be controlled before they become a problem.

The Nseleni/Mposa rivers and Lake Nsezi scenario is an example of what can be achieved on limited budgets but with vast amounts of enthusiasm.

Acknowledgments

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