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# Zambia Aquaculture Enterprise Development Project (ZAEDP): Genetic improvement program



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## Authors

Rose Komugisha Basiita, Chungu Patience, Malambo Tom, Hampuwo Buumba, Keagan Kakwasha, Agness Chileya and Victor Siamudaala.

## Citation

This publication should be cited as: Basiita RK, Chungu P, Malambo T, Hampuwo B, Kakwasha K, Chileya A and Siamudaala V. 2022. Zambia Aquaculture Enterprise Development Project (ZAEDP): Genetic improvement program. Penang, Malaysia: WorldFish. Program Brief: 2022-09.

## Acknowledgments

This work was undertaken as part of the CGIAR Research Program on Fish Agri-Food Systems' (FISH) Zambia Aquaculture Development project (ZAEDP) led by [WorldFish](#). The program was supported by contributors to the [CGIAR Trust Fund](#). The African Development Bank through the government of the republic of Zambia provided funding for this work.

## Contact

WorldFish Communications and Marketing Department, Jalan Batu Maung, Batu Maung, 11960 Bayan Lepas, Penang, Malaysia. Email: [worldfishcenter@cgiar.org](mailto:worldfishcenter@cgiar.org)

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# 1. Introduction

With technical support from WorldFish, the government of Zambia is implementing a genetic improvement program (GIP) for the indigenous three-spotted tilapia (*Oreochromis andersonii*) (Plate 1) under the Zambia Aquaculture Enterprise Development Project (ZAEDP). The duration of the ZAEDP is 5 years, from 2017 to 2022. However, the GIP only commenced later in 2019. The GIP addresses key constraints in the aquaculture industry, including poor quality seed associated with slow growth and low survival, especially among indigenous species. The GIP for three-spotted tilapia aims to improve the growth rate, harvest weight and survival of the species, which are key desirable traits in aquaculture contributing to increased productivity and profitability.



Photo credit: Agnes Chiloya/WorldFish

**Plate 1.** Three-spotted tilapia.



## 2. Components of the GIP

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- a. Develop a national GIP for three-spotted tilapia.
- b. Draft a strategy report for seed production and dissemination of the three-spotted tilapia.
- c. Draft a strategy report for cleaning up Nile tilapia (*O. niloticus*).
- d. Build the capacity of national scientists through core supervision of interns and both master's and doctoral students.
- e. Work hand in hand with officers from the Department of Fisheries (DOF) throughout the GIP.
- f. Build capacity and transfer skills throughout the course of the GIP by engaging government officers, the private sector and interns at all levels of the aquaculture industry, as well as post-graduate students.

### 3. Design and approach for building the broodstock foundation

The project has so far developed a disease-free broodstock foundation for three-spotted tilapia. This briefly highlights the following procedures that were used to build the stock at the National Aquaculture Research and Development Centre (NARDC) in Mwekera, Kitwe:

- a. The broodstock was collected from various water systems where three-spotted tilapia naturally occur, including the Zambezi, Luangwa and Kafue river systems.
- b. Rigorous screening was undertaken through tissue sampling and laboratory analysis (Plate 3) for epizootic ulcerative syndrome (EUS) and tilapia lake virus (TiLV) to ensure we use disease-free broodstock, because diseases can result in high economic losses.



**Plate 2.** Stocking broodstock in conditioning hapas at the NARDC Mwekera in Kitwe.



**Plate 3.** Tissue sampling for laboratory analysis.

- c. The fish were held separately by population, origin and sex in net enclosures and given special broodstock feed to enable proper gonadal development and sufficient conditioning for breeding (Plates 2 and 4). To expedite egg development in the females, fish oil was added to the feed.



**Plate 4.** Conditioning hapas at the NARDC.



**Plate 5.** A cryo-vial with a fin clip for DNA extraction.

- d. After confirming that the fish were healthy, they were then tagged, genotyped and mated within and across populations, following an agreed-upon mating design to produce the base population.
- e. We adopted Passive Integrated Transponder (PIT) tags to identify the fish. Identification of broodstock, families and offspring in a GIP is critical for traceability.
- f. Fin punches were obtained using non-lethal techniques for the purposes of genotyping (Plates 5 and 7). The genotypes were used to identify fish and ensure that unrelated individuals were mated to produce a genetically diverse population.
- g. The project aimed to produce a large and diverse number of initial families (100–200) to minimize the effects of cumulative inbreeding from one generation to another. This will ensure a sustainable national breeding program.



**Plate 6.** Inserting a PIT.

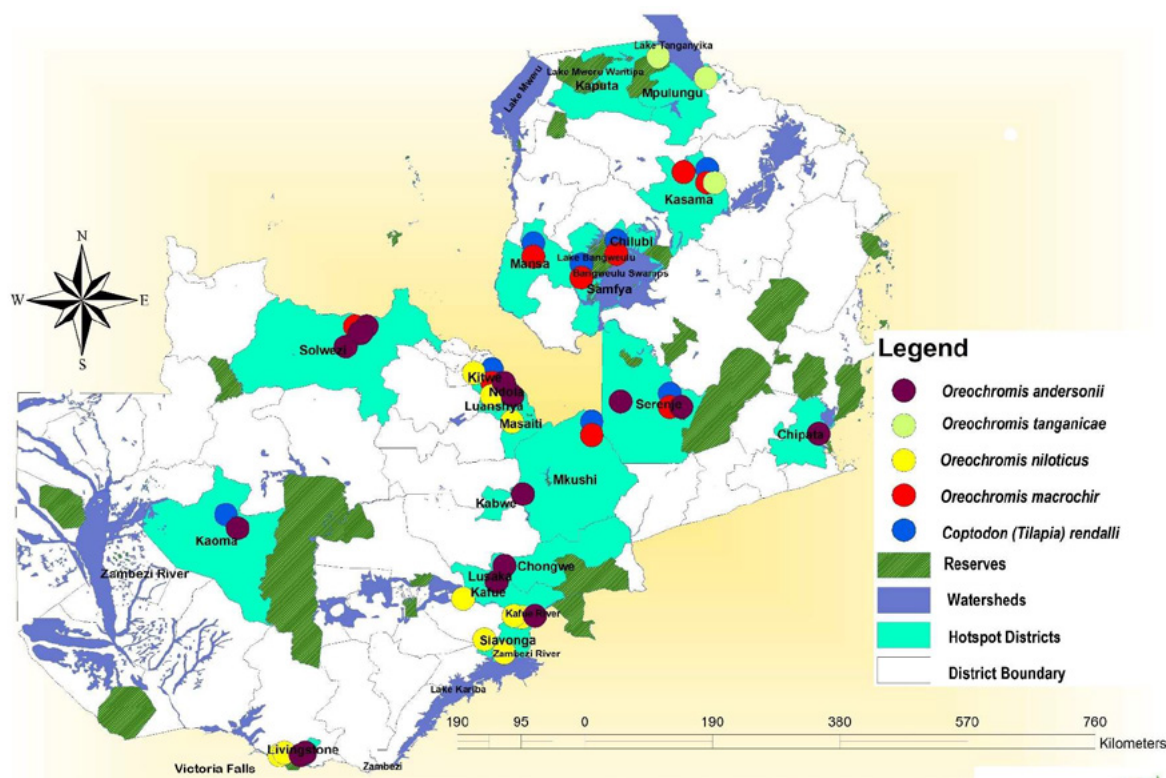


**Plate 7.** Fin clipping.

## 4. Milestones achieved

In partnership with the DOF, the following are the milestones that have been achieved to date:

- A tilapia species map covering over 30 hatcheries in Zambia was generated (Figure 1). Out of the five tilapia species mapped across the hatcheries, the most cultured were the three-spotted tilapia and Nile tilapia. Of the hatcheries, 72% were private and the remaining 28% were public.
- To run the breeding program at the NARDC smoothly, WorldFish provided technical assistance to install and test the low-cost biosecure hatchery currently at NARDC incubating up to 120 families at any one given time.
- Broodfish were recruited and screened for disease prior to inclusion in the genetic improvement program.
- As a result of process, WorldFish worked with the Department of Veterinary Services to provide hands-on training in disease screening to other staff members of the DOF from several research stations. These included the Chipata, Kaoma, Solwezi and NARDC government stations. Fish disease screening specifically targeted EUS and TiLV, which are both major diseases of economic importance in the tilapia industry.
- Further hands-on training on fin clipping, tagging and family production were also done to strengthen the capacity for the national genetic improvement program.
- Currently, over 100 families have been produced from which a genetically diverse base population (G0) has been built for the National Genetic Improvement Program.
- A dissemination strategy for the improved three spotted Kafue bream has been developed.



Note: Survey was undertaken in 2019–2020.

**Figure 1.** Distribution of tilapia species as identified in hatcheries across Zambia.



These families were produced and incubated in the GIP hatchery at the NARDC (Plate 9).



**Plate 8.** Hapas in ponds used for mating at the NARDC.



**Plate 9.** Minister of Fisheries and Livestock Makozo Chikote, MP, visits the GIP hatchery at the NARDC.

In preparation for tagging, fry were reared in hapas in ponds until they reached 5 g.



**Plate 10.** Day-old swim-up fry placed in a nursing hapa.



**Plate 11.** A sample of F1 (G0) three-spotted tilapia harvested from GIP grow-out ponds at the NARDC.

Finally, through various stakeholder meeting engagements, the following strategic reports have been produced under the project:

1. A dissemination strategy report for the improved Kafue bream has been developed to contribute to the sustainability of the GIP.
2. A draft strategy report for cleaning up Nile tilapia is currently under review.



**Plate 12.** A multistakeholder consultative meeting on the development of the Nile tilapia strategy.



**Plate 13.** Present at the meeting were the deputy director of aquaculture (DOF) Mr. Mbamwai Mbewe, GIP project lead Dr. Rose Basiita (WorldFish) and chairperson (ADAZ) Mr. Fisho Mwale.

## 5. Next steps

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- a. The best performing candidates from this generation are being selected selected to constitute the first ever genetically improved population, targeting growth and survival as key traits for the aquaculture industry.
- b. Led by the government, WorldFish will continue to engage with industry, small and medium enterprises and other partners to promote investments in the GIP and ensure sustainability.

Overall, improved growth through the GIP will contribute to the production of a fish crop in a relatively short time. A shorter growth period for the indigenous three-spotted tilapia in Zambia will mean fewer inputs and a smaller carbon footprint while maximizing production and profitability in a sustainable manner. Lessons learned from the GIP will provide a framework for future GIPs in Zambia and the region.



## About WorldFish

WorldFish is an international, not-for-profit research organization that works to reduce hunger and poverty by improving aquatic food systems, including fisheries and aquaculture. It collaborates with numerous international, regional and national partners to deliver transformational impacts to millions of people who depend on fish for food, nutrition and income in the developing world.

The WorldFish headquarters is in Penang, Malaysia, with regional offices across Africa, Asia and the Pacific. The organization is a member of CGIAR, the world's largest research partnership for a food secure future dedicated to reducing poverty, enhancing food and nutrition security and improving natural resources.

For more information, please visit [www.worldfishcenter.org](http://www.worldfishcenter.org)